

NUCLEAR TESTING ISSUES

HEARINGS

BEFORE THE

COMMITTEE ON FOREIGN RELATIONS

UNITED STATES SENATE

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NUCLEAR TESTING ISSUES

THURSDAY, MAY 8, 1986

U.S. SENATE,
COMMITTEE ON FOREIGN RELATIONS,
Washington, DC.

The committee met at 9:30 a.m., in room SD 419, Dirksen Senate Office Building, Hon. Daniel J. Evans presiding.

Present: Senators Mathias, Kassebaum, Pressler, Tribble, Evans, Pell, Biden, Cranston, and Kerry.

Senator EVANS. This meeting of the Foreign Relations Committee will come to order.

This morning, the Foreign Relations Committee begins a comprehensive examination of nuclear test issues. Members of this committee and of the Senate share a deep interest in this subject with the people of our country and the people of all nations of the world.

Nuclear testing is an extremely complex and technical matter that evokes strong emotions. It is susceptible to polemics and propaganda. Yet, it is a deadly serious matter.

It has a direct bearing on our national security and our foreign policy. At the extreme, it affects our very survival.

Therefore, it is fitting that this committee undertake a thorough, comprehensive review of this important issue, carefully examining all of its facets.

Since the dawn of the nuclear age, people have questioned whether we should continue to test nuclear weapons. Beginning with President Dwight Eisenhower, every President has pursued limits on testing as a means to control the proliferation of nuclear weapons. There have been successes, failures, and frustrations, and tremendous controversy.

After years of negotiating amid public controversy, President Kennedy was able to conclude the Limited Test Ban Treaty of 1963, which banned all tests in the atmosphere, under water, and in space. Many viewed the treaty as a great triumph; nonetheless, some argue that we have not limited testing as much as we can, or should.

Since 1963, as both the United States and the Soviet Union have sought to maintain their respective deterrent forces, the size and the composition of these forces have grown.

A test ban by itself does not reduce the number of nuclear weapons in the world today, nor does a test ban offer a solution to the problems which cause nations to build weapons.

Our purpose here is to explore whether greater limits on testing are consistent with our national security objectives.

Arms control can play an important role in our national security strategy. Each arms control proposal must be examined carefully to determine how it might enhance our security and contribute to global stability. We should approach the nuclear testing issue in the same way. Would a ban, a moratorium, or a lower yield threshold make us more secure? Have recent technological advances made greater limits a more realistic objective? Can greater limits in conjunction with other efforts help stop the arms race?

Are greater limits on testing the logical first step, and must we proceed in a linear fashion?

If we determine that greater limits on testing is a positive step toward eliminating nuclear weapons, we must then consider whether our deterrent forces would effectively maintain stability and security and would such limits be verifiable?

As we examine the nuclear testing issue in this committee, I believe we should consider three things.

First, we must recognize that there are, in fact, several issues involved. For example, how do we view the Threshold Test Ban and the Peaceful Nuclear Explosions Treaties, which can be examined independently from proposals for a ban, a moratorium, or a lower yield threshold?

Second, we should consider the context in which a further limitation on nuclear testing makes sense. Would a ban, a moratorium, or a lower threshold effectively put us on the path to real reduction, or are real reductions a prerequisite to a meaningful limit on testing?

Third, we must consider what is verifiable. We should examine the current status of the TTB and the PNE Treaties. We should also examine how any proposed testing limitations can be effectively verified.

To answer these fundamental questions, we must consider the relationship between nuclear testing and deterrence. Is testing really necessary to maintain force reliability? Is testing necessary for stabilizing force modernization? Do we need to test the effects of a nuclear environment on components of our defense system, such as modernized command, control, or communications?

Are there safety or security reasons which warrant continued testing? And, are there nonmilitary reasons for continued testing, such as testing for new energy technologies, or for medical research?

This is an extremely complex and technical matter.

We are fortunate to have four knowledgeable and capable people before us today with whom we can begin our examination.

Before I turn to our first witness, Senator Pell, do you have an opening statement?

Senator PELL. Thank you, Mr. Chairman. I do.

I join you in being glad that the administration will be setting forth its stance on test ban issues.

The committee will also be hearing from witnesses with various different views in later hearings.

I remain a firm advocate of a complete halt to nuclear testing. A number of other members of our committee have also taken strong stands for a test ban.

In 1984, the Senate gave its strong endorsement in calling upon the President to seek Senate advice and consent to ratification of the 1974 Threshold Test Ban Treaty, the TTBT, and the 1976 Peaceful Nuclear Explosions Treaty, or PNET. That call for Presidential action was reiterated by the House this year in House Joint Resolution 3.

I have introduced for Senator Danforth and myself and 19 co-sponsors a new resolution, Senate Joint Resolution 252, renewing the call for Presidential support for ratification of the TTBT and the Peaceful Nuclear Explosions Treaty, and for resumption of negotiations on a comprehensive test ban, which could be achieved in one step or in balanced steps.

In addition, our Pell-Danforth resolution urges the President, at the earliest possible date to:

First, call upon the Soviet Union to join in a further agreement reducing the permitted yields of explosions, as specified in the Threshold Test Ban Treaty and the Peaceful Nuclear Explosions Treaty, to the lowest possible verifiable levels which advances in seismic detection and other verification capabilities will allow.

Second, to seek Soviet agreement to facilitate negotiations by declaring at the earliest practicable date a mutual moratorium of finite duration on nuclear explosions.

With the TTBT formally in place, the administration would be in a position to seek a substantially lowered threshold and expanded verification, as appropriate.

That would take care of any particular verification problems. A radically lower ceiling for tests—which could be only a small fraction of the current ceiling of 150 kilotons—could be agreed upon in safety, given our advances in technologies.

With such steps behind us, we would be in an excellent position to move on to negotiation of a complete ban. That could be instituted at a date certain or phased in over several years, to allow any necessary testing for reliability and durability to be conducted before the complete stop.

A moratorium of finite duration—such as 1 year, to be specific—would open the way to a serious resumption of the negotiations on a comprehensive test ban agreement, conducted earlier by the Carter administration. Progress on verification matters had been made in those negotiations. The sides had agreed to allow seismic monitoring stations on their own territories, and details on inspections on demand to look into suspicious seismic activity were actually being worked out.

In other words, onsite inspection was accepted.

Thus, the two sides would not be starting from scratch. A finite duration to a moratorium would give the sides reason to conclude their work expeditiously, although, if success were in sight, there would be nothing wrong with a brief extension of the moratorium.

I believe that the test ban agenda I have described is a practical one. It is clear that steadily improved controls on nuclear testing, culminating in a ban on all nuclear explosions, offers many critically important benefits.

Over time, confidence in the reliability of our warheads would erode, although actual reliability should remain high for the near future. Eventually, however, the reliance placed on nuclear weap-

ons by both sides would decline, and that would be to everyone's benefit, because there would be less likelihood of any country trusting its fate to a weapon whose reliability was in doubt.

A moratorium followed by a ban would also curb the modernization of United States and Soviet nuclear weapons. This could prevent them, too, from developing any new, smaller warheads with high weight to yield ratios to be proliferated on their missile forces, especially MIRV's.

It could also impede the development of new technologies, such as x-ray lasers driven by nuclear explosions.

All told, it is as Mr. Gorbachev said to us in Moscow, just a few months ago, that systematic testing is needed if new weapons are to be developed or old weapons are to be kept up to date and up to snuff.

If this testing is stopped, it would mean that in a period of years, in 20, 30, or 40 years, that, one, there would be no more new weapons, and, two, we would be fools to use the weapons we presently have in our inventories because we would not be sure of them or confident.

The moratorium and ban would put pressure, too, on the Chinese and the French to stop their testing programs, and a halt by the nuclear nations would certainly deter other nations from starting their own testing programs.

Finally, such steps by the superpowers would serve to reinforce the resolve of the 127 nations who have foresworn nuclear weapons. A ban open to all nations could well give new life to the crucial effort to stop the spread of nuclear nations.

Mr. Chairman. I would ask that the balance of my statement be inserted into the record, as if read.

Senator EVANS. The entire statement will be inserted into the record.

[The opening statement of Senator Pell follows:]

OPENING STATEMENT OF SENATOR CLAIBORNE PELL

Mr. Chairman, I am glad the Administration will have the opportunity to set forth its stance on test ban issues this morning. The Committee will also be hearing from witnesses with diverse printed views in later hearings.

I remain a firm advocate of a complete halt to nuclear testing. A number of other Members of the Committee have also taken strong stands for a test ban. In 1984, the Senate gave its strong endorsement in calling upon the President to seek Senate advice and consent to ratification of the 1974 Threshold Test Ban Treaty and the 1976 Peaceful Nuclear Explosions Treaty. That call for presidential action was reiterated by the House this year in H.J. Res. 3.

I have introduced for Senator Danforth and myself and 19 cosponsors a new resolution, S.J. Res. 252, renewing the call for presidential support for ratification of the TTBT and PNET treaties and for resumption of negotiations on a CTB, which could be achieved in one step or in balanced steps.

In addition, the Pell-Danforth resolution urges the President, at the earliest possible date to:

Call upon the Soviet Union to join in a further agreement reducing the permitted yields of explosions, as specified in the Threshold Test Ban Treaty and the Peaceful Nuclear Explosions Treaty, to the lowest possible verifiable levels which advances in seismic detection and other verification capabilities will allow.

Seek Soviet agreement to facilitate negotiations by declaring at the earliest practicable date a mutual moratorium of finite duration on nuclear explosions.

With the TTBT formally in place, the administration would be in a position to seek a substantially lowered threshold and expanded verification as appropriate. That should take care of any particular verification problems. A radically lower ceil-

ing for tests—which could be only a small fraction of the current ceiling of 150 kilotons—could be agreed upon in safety, given advances in technologies.

With such steps behind us we would be in an excellent position to move on to negotiation of a complete ban. That could be instituted on a date certain or phased in over several years to allow any necessary testing for reliability and durability to be conducted before the complete stop.

A moratorium of a finite duration—such as one year—would open the way to a serious resumption of the negotiations on a comprehensive test ban agreement conducted by the Carter administration. Considerable progress on verification matters had been made in these negotiations. The sides had agreed to allow seismic monitoring stations on their territory, and details on inspections on demand to look into suspicious seismic activity were being worked out. Thus, the two sides would not be starting from scratch. A finite duration to a moratorium would give the sides reason to conclude their work expeditiously, although, if success were in sight, there would be nothing wrong with a brief extension of the moratorium.

I believe that the test ban agenda I have described is a practical one. It is clear that steadily improved controls on nuclear testing, culminating in a ban on all nuclear explosions, offers many critically important benefits:

Over time, confidence in the reliability of our warheads would erode, although actual reliability should remain high for some time. Eventually, however, the reliance placed on nuclear weapons by both sides would decline, and that would be to everyone's benefit.

A moratorium followed by a ban would curb the modernization of United States and Soviet nuclear warheads. This could prevent them from developing new, smaller warheads with high weight-to-yield ratios to be proliferated on their missile forces, especially MIRV's. It could also impede the development of new technologies, such as x-ray lasers driven by nuclear explosions.

A moratorium and ban would put pressure on the Chinese and the French to stop their testing programs, and a halt by the nuclear nations would certainly deter other nations from starting their own testing programs.

Finally, such steps by the superpowers would serve to reinforce the resolve of the 127 nations who have foresworn nuclear weapons. A ban open to all nations could well give new life to the crucial effort to stop the spread of nuclear nations.

Mr. Chairman, I wish I believed that the Administration were willing to work with me and with others in the Congress to chart a sensible course toward a test ban. Unfortunately, the Administration is now at an impasse with the Soviet Union on the TTBT and PNET and continues to reject the CTB out of hand. The Administration has been supremely indifferent to the thoughts of others, except when the outcry has been too great to ignore. For example, the Committee on Foreign Relations on January 3 requested Administration comment on S.J. Res. 252. We have not been given the courtesy of a reply.

Unfortunately, it is often very hard to push a good idea through various obstacles to success and substantially easier to thwart the good ideas of others. Too frequently, the Administration has contented itself with the low-road approach of blocking advances.

I find it simply outrageous that we have allowed the Soviets to have the high road on a number of arms control issues, including test ban initiatives. Rather than simply claiming that the Soviets are not serious, we should be putting them to the test. We should make them put up or shut up. We should be doing our utmost to get their agreement to strong, verifiable arms control accords or show them up as fakers.

Since 1981, there has been a lot of Administration talk about arms control but there have been no major agreements. Apparently, none is in prospect. If the Administration leaves office in 1989 with no record of arms control achievement, it may please a few short-sighted officials, but it should be a source of acute regret and embarrassment for those who understand the central value of arms control to our national security.

I hope that our witnesses this morning will be able to make the case that prospects are brighter than I think. If so, no one will be more delighted than I.

Thank you, Mr. Chairman.

Senator EVANS. With that, we turn now to our distinguished witnesses. We have written testimony from Mr. Barker and Mr. Holmes. The entire statements will be included in the record.

Since this issue is of extreme importance, we would like you to proceed in any way you wish, presenting as much or all of your statement that you would like to read into the record, if necessary.

We would first call on Ambassador Allen Holmes, Director of Politico-Military Affairs of the Department of State.

Ambassador Holmes.

**STATEMENT OF HON. H. ALLEN HOLMES, DIRECTOR, OFFICE OF
POLITICO-MILITARY AFFAIRS, DEPARTMENT OF STATE**

Ambassador HOLMES. Good morning, Mr. Chairman.

I will make an oral statement which will be a somewhat truncated version of the written statement I have submitted for the record.

I welcome this opportunity to appear before you for the purpose of addressing the administration's nuclear testing arms control policy, with a particular focus on a comprehensive nuclear test ban.

I will outline the administration's nuclear testing policy, comment on a CTB as an issue in international politics, review our historical experience with nuclear test bans, give an assessment of the Soviet Union's public position on nuclear testing issues, and conclude with a statement on how some pending nuclear testing legislation affects the administration's ability to handle national security problems.

The administration supports a verifiable, comprehensive test ban as a long-term goal. But for a test ban to strengthen global peace and security, certain conditions must precede its implementation, and those conditions do not exist today.

Let me explain.

The fact is that the United States, its allies, and its friends rely on nuclear weapons for deterrence. So long as we continue to depend on a secure and credible nuclear deterrent as the ultimate guarantor of peace with freedom, it is difficult to envision circumstances where some level of testing would not be necessary to insure the safety, reliability, effectiveness, and survivability of our nuclear weapons.

A complete cessation of nuclear tests must be viewed in its relationship to the entire strategic situation. As we have stated often, a CTB remains a long-term objective of the United States in the context of achieving broad, deep, and verifiable arms reduction, substantially improved verification capabilities, expanded confidence building measures, and great balance in conventional forces, and at a time when a nuclear deterrent is no longer as essential an element as currently for international security and stability.

The United States is currently involved in discussions with the Soviet Union in these areas.

The United States supports and engages in international discussion of verification and compliance problems related to nuclear testing limitations. We have actively participated in such discussion in past years at the multilateral Conference on Disarmament in Geneva, at the technical level and ad hoc group of scientific experts and in the Nuclear Test Ban Working Group.

The United States continues to support consideration of monitoring and verification issues related to a CTB in these two groups at the Geneva Conference on Disarmament.

United States testing policy is fully consistent with obligations under the 1963 Limited Test Ban Treaty and the Nonproliferation Treaty.

In the preambles to those agreements, the parties cited their determination to continue negotiations toward the discontinuance of nuclear weapons testing, but did so within the wider context of the goal of general and complete disarmament under strict international control and the elimination of nuclear weapons altogether.

A test ban will not, by itself, eliminate the threat posed by nuclear weapons, and limitations on testing must necessarily be considered within a broad range of arms reductions, both conventional and nuclear. To this end, the United States remains committed to achieving equitable and verifiable agreements leading to substantial reductions in nuclear arsenals.

The issue of verification remains a difficult problem that is essential to an effective and sustainable arms control process, including the area of nuclear testing. Over the past 3 years, we have placed the highest priority in the nuclear testing area on finding an effective means of verification of the 1974 Threshold Test Ban Treaty, and the 1976 Peaceful Nuclear Explosions Treaty.

We have suggested concrete means of building confidence by extending a unilateral and unconditional invitation to the Soviet Union to send experts to measure directly the yield of a nuclear test at our test site.

On March 14 of this year, the President went even further, and urged the Soviet Union to join the United States in discussions on finding ways to reach agreement on essential verification improvements of the TTBT and PNET. He provided details to the Soviet Union on the U.S. Corrtex hydrodynamic measurement system, and proposed that Soviet scientists come to our Nevada test site last month to examine Corrtex fully.

The President added that if the Soviets would join us in an agreement on the use of an effective verification system incorporating the use of Corrtex, the United States would be prepared to move forward on ratification of the TTBT and PNET.

The Soviets say they want progress on testing limitations. They recently have claimed in public that they are willing to accept on-site inspections, when necessary. On both counts, they should be able to accept our offers which could lead to substantial progress in resolving our differences concerning the TTBT and PNET.

Unfortunately, however, they have spurned our proposals for TTBT and PNET verification improvements, suggesting a moratorium on nuclear tests. The Soviets know full well that we cannot accept a moratorium on testing. They know very well that, as a result of their unexpected breakout from the 1958-61 moratorium, the United States has no confidence that such moratoria can be counted on to lead to enhanced security.

To quote President Kennedy:

"We know enough now about broken negotiations, secret preparations, and the advantages gained from a long test series never to offer again an uninspected moratorium."

Except for negotiations on strategic nuclear forces, no arms control endeavor since World War II has generated such sustained international interest, as has the issue of nuclear testing. Rising concern about radioactive fallout in the 1950's spurred efforts to halt testing, as the nature and effects of fallout became better understood and as it became apparent that no region was untouched by radioactive debris.

Efforts to negotiate an international agreement ending nuclear tests began in the U.N. Disarmament Commission in May 1955. For the next 6 years, progress was frustrated by differences among the five participants—the United States, United Kingdom, Canada, France, and the Soviet Union—over whether a nuclear test ban should be negotiated by itself or whether it should be contingent upon progress on other arms control issues, particularly on a cutoff in production of fissionable materials for weapons and safeguards against surprise attack.

The central and most persistent barriers to a treaty limiting tests, however, were, and are today, the essential role of testing in maintaining an effective nuclear deterrent and the means of verifying compliance that could guarantee against testing in secret.

The danger, both to Western security and to progress toward genuine arms control, of supporting arms control agreements without effective verification was underscored by the fate of an international testing moratorium. Unilateral, but parallel, cessation of testing was observed by the United States, the Soviet Union, and the United Kingdom from 1958 to 1961. As President Kennedy stated in 1962:

On September first of last year, while the United States and the United Kingdom were negotiating [on a test ban] in good faith in Geneva, the Soviet Union callously broke its moratorium with a 2-month test series of over 40 nuclear tests. Preparations for these tests had been secretly underway for many months.

These tests were conducted in the atmosphere. The United States and the United Kingdom proposed on September 3, 1961, that all atmospheric tests be ended without any requirement for international control.

On September 15, in the face of continuing Soviet tests, the United States resumed testing.

The Soviet tests not only ended the moratorium, but represented a clear breach of faith.

From 1977 through 1980, the United States, the United Kingdom and the Soviet Union held negotiations on a comprehensive test ban. The three parties failed to reach agreement on several major issues, including some dealing with verification. The specific verification issues involved the conditions for carrying out onsite inspections and the use of seismic equipment on the territory of each monitored party.

The United States sees objective security risks in resuming trilateral negotiations on a comprehensive test ban at this time, given our reliance on nuclear weapons to deter aggression. However, a treaty banning all nuclear testing remains a long-term objective of U.S. arms control policy in the context of the criteria which I have stated above.

The United States has participated in the formation of a working group in the Conference on Disarmament in Geneva to discuss

issues related to verification and compliance with any future comprehensive test ban. A test ban cannot, by itself, end the nuclear threat, nor will it remove the threat from conventional Soviet forces.

Soviet intentions on a cessation on testing must be questioned. It is clear that Soviet public claims of interest in a CTB contain a large element of propaganda of the most blatant type.

Soviet General Secretary Gorbachev's March 29 televised address was the latest addition to his regimes propaganda innovations. The Soviet Union has been fully informed through diplomatic channels of the reasons for our refusal to negotiate a CTB at this time, and of the total unacceptability of an unverified moratorium.

The Soviet Union has also failed to agree to our concrete initiatives which are designed to build confidence in nuclear testing limitations.

As you know, members of Congress have introduced legislation that attempts to force the administration to enter CTB negotiations or to join a Soviet moratorium. We oppose such legislation.

It would undercut the initiatives the President has proposed to make progress in nuclear test limitation issues, and such legislation would set back prospects on a broad range of arms control efforts, including the achievement of deep, stabilizing, and verifiable arms reductions.

I request that you join us in opposing measures that aim to force us into further limitations on testing under conditions that could weaken our national security.

Any limitations on nuclear testing must be compatible with our security interests and must be effectively verifiable.

We think there are good opportunities for progress in arms control, including nuclear testing. So far, however, the Soviets have not availed themselves of these opportunities.

We have proposed deep reductions in strategic nuclear systems. The Soviets have yet to respond to our proposals of last November. In February, we proposed elimination of the entire class of longer range INF missiles. We hope for a constructive Soviet response in the new round of NST talks which begin today in Geneva.

On nuclear testing, our position has consistently been that what is needed now is to enhance confidence in verification of the TTBT and PNET. We place top priority on the achievement of a reasonable and effective system by which we can verify compliance with the 150 kiloton threshold of the Threshold Test Ban Treaty and the Peaceful Nuclear Explosions Treaty.

The United States has made a series of concrete proposals to the Soviet Union in this regard, most recently on March 14 of this year. In the meantime, we have made it absolutely clear that we require nuclear testing for our security and the security of our allies. We intend to continue with our testing programs.

The Soviets have been making preparations for some time to resume nuclear testing. When they choose to resume is their decision. They have told us they are no longer bound not to test.

Regrettably, the Soviet Union has not accepted any of our initiatives, which were aimed at taking constructive steps toward addressing our mutual concerns. Nonetheless, the President remains

convinced that our two nations can find common ground on the nuclear testing issue.

Finally, I ask you, therefore, to continue your support and efforts to help us pursue our responsible nuclear testing goals.

Thank you, Mr. Chairman.

[The prepared statement of Ambassador Holmes appears in the appendix.]

Senator EVANS. Thank you very much, Mr. Holmes.

Next we will hear from Mr. Robert Barker, Deputy Assistant Director for Verification and Intelligence, U.S. Arms Control Disarmament Agency.

STATEMENT OF ROBERT B. BARKER, DEPUTY ASSISTANT DIRECTOR FOR VERIFICATION AND INTELLIGENCE, U.S. ARMS CONTROL AND DISARMAMENT AGENCY

Mr. BARKER. Senator Evans, thank you very much.

It is my intention this morning to focus my remarks on the technical foundations of the administration's views on nuclear test limitation treaties.

In that regard, I want to touch both upon our position with respect to the Threshold Test Ban Treaty and with respect to a Comprehensive Test Ban Treaty.

The President has indicated in a recent letter to Senator Dole the conditions under which we could consider a Comprehensive Test Ban Treaty.

He has said that the comprehensive test ban is an objective that we will seek to pursue within the context of broad, deep, and verifiable arms reductions, substantially improved verification capabilities, a greater balance in conventional forces, and at a time when a nuclear deterrent is no longer as essential an element as currently for international security and stability.

The two elements of this statement on which I want to concentrate are the need for substantially improved verification capabilities and the role that nuclear testing plays in the maintenance of our nuclear deterrent.

I would like to summarize my statement for the record very briefly by pointing out that the nuclear testing program of the United States consists of basically four categories of nuclear tests. Each of those categories is intimately related to the maintenance of our nuclear deterrent and to the maintenance of stability in the world.

The first of those categories is the category of stockpile reliability and confidence tests.

Each year, a few tests are conducted in this category, which are tests either to confirm that a weapon which has just been produced, a typical weapon off the production line of a new weapon program, will indeed perform as it is called upon to do so, to make sure that no imperfections, that no mistakes have been made in the actual manufacturing process.

So, for each new weapon system that comes off the production line, one weapon of that category is tested in a stockpile confidence test.

We also do tests of weapons that have been in the stockpile for some time, weapons which have been subjected to the corrosion and aging that happens to all things over the course of time. In this regard, nuclear weapons are no different from any category of appliance in the common household or any other form of military equipment. Chemical processes take place over the years that require some assessment as to whether they will, indeed, affect the performance of that particular object. In this case, it is a nuclear weapon.

We do not routinely go out and take nuclear weapons out of the stockpile and test them in a statistical sense. The process is much too expensive to do that.

What we do, instead, is depend upon the judgment of the scientists and engineers from the nuclear weapons laboratories who have designed those weapons. When we tear down a weapon and look at it, we ask those scientists and engineers to make an assessment. Are the changes that have occurred over the course of time such as to cause us to be concerned either about the performance of that weapon, or is there any reason to be concerned about the safety of that weapon?

Routinely, their answer is that the changes that they have observed are not such as to cause a loss of confidence. But, every now and then—and, luckily, the instances have not been too many—in their judgment, when they look at the changes that have occurred, they conclude that a nuclear test is required either to confirm that a serious problem has occurred or that in order to fix such a problem, a nuclear test is required to confirm that the fix has indeed worked.

Over the course of time problems in the stockpile, of course, have been a matter of great security concern to the United States, and it has only been recently that there is any kind of information available about the historic stockpile problems that have occurred in the stockpile.

I would like to submit for the record a report prepared by the Department of Energy, authored by Dr. Jack Rosengren, called, "Some Little Publicized Difficulties With a Nuclear Freeze."

Senator EVANS. We will include that with the record.

[The information referred to appears in the appendix.]

Mr. BARKER. In that document, Dr. Rosengren outlines a half dozen problems that have occurred historically in the U.S. stockpile.

In one of those cases, it was discovered that a particular warhead for the Polaris missile was such that degradations had occurred over the course of time, such that 75 percent of those weapons would not have worked had they been detonated.

Now, that is not a small, gradual erosion over the course of time. That is a true catastrophe. That is what we talk about when we talk about the potential negative impact of a comprehensive test ban on nuclear weapon reliability.

It is not the gradual erosion over time that occurs to all of us, even. It is the fact that at some point in time, a trigger threshold may be passed at which a catastrophic failure occurs due to the effects of age. In this case, it is age in a nuclear weapon, such that one day we have total faith in that weapon, and the next day we

have reason to believe that a large fraction of the weapons in the stockpile of that type will not work.

This problem that I cited with the Polaris warhead was addressed by nuclear weapons designers. A fix was designed. The weapon with the fix in it was tested and proved satisfactory. As a result, the entire stockpile of that weapon was recalled and fixed in order to restore confidence in it.

So, I have just talked now about the first category of nuclear weapons testing, nuclear weapons confidence and reliability. I have pointed out that it is of two kinds—routine testing of each new warhead as it comes off the production line, and tests that are the result of discovered problems in the stockpile.

I have said that those kinds of tests are a small fraction of the total, but they are a very, very critical fraction, a very, very critical component if we are to continue to have faith in our nuclear deterrent.

The second category is nuclear weapons effects tests.

Again, these are a small number of tests each year. These tests are managed by the Department of Defense, the Defense Nuclear Agency. In these tests, the nuclear explosion is the source for providing a test bed through which we can test the survivability of our nuclear weapons systems and our command and communications systems.

If our deterrent system is to work, we must be confident that we can detect attack, that we can make assessment of threat, and that we have confidence that our nuclear weapons systems will not and cannot be destroyed easily should the Soviets attack.

We also want the Soviets to have full confidence that we are confident in our deterrent, that it is survivable against whatever measures they may take.

So, each year a few tests are conducted in which we expose re-entry vehicles, satellite components, military hardware of all varieties to the effects of a nuclear detonation to see whether they have met their design criteria.

Tests of this category are just as critical to the maintenance of the deterrent as are tests which confirm that the yield of the weapon is what it should be.

We cannot be confident that our military systems can survive reasonably well in nuclear environments if we have no basis for faith in our deterrent. We need to believe that those systems can be sufficient survivable to constitute a true deterrent.

The third category of tests are tests that are devoted to the development of new weapon concepts—I want to make clear that it is concepts that I am talking about here—tests that are devoted to developing specific weapons for the stockpile, and tests that are devoted to understanding how nuclear energy may be applied to military purposes, not necessary by ourselves, but by others.

In this category, we find the tests for the MX missile. Also falling into this category are new tests for the Trident II warhead and tests for the proposed Midgetman warhead. They would fall into this category of tests which are designed to develop weapons for specific applications.

In a more general category, part of the nuclear testing process is to design features which will enhance the already high safety and security standards that we have for our nuclear weapons.

As these concepts are developed through this category of testing, they are incorporated into the new weapon systems as they are built.

In this area, the safety concept that probably has received the most attention has been the development of an insensitive high explosive which, literally, cannot be exploded, or will not detonate unless ignited purposefully by the way in which it was intended. It will not explode in any kind of conceivable accident situation. It is very clearly a desirable feature for every weapon in our nuclear inventory. There are many, many weapon systems yet deployed that do not have this feature.

As we replace those systems in the future, we will incorporate this insensitive high explosive and, thus, dramatically enhance the safety of our stockpile.

The third category is that of understanding the potential threat that others may pose via their developments in their nuclear weapons program.

It is important to understand that nuclear weapons design is not a linear process. By this, I mean that every country which has developed nuclear weapons may have started at a very similar point. But, in subsequent tests—the 2d, 3d, 4th, 10th, et cetera—there is no requirement in the physics of nuclear weapons that each nation pursue an identical path. Therefore, it is quite possible, in fact, even probable, that the Soviets have discovered nuclear weapons concepts that we have not yet fully mastered.

We do not know that, of course, as a fact, but it certainly is a possibility. So, we continue to try to better understand how nuclear energy may be applied for military purposes whether we intend to incorporate those concepts or not.

It is in this category that work on some of the so-called nuclear concepts associated with SDI have been undertaken. While the President's goal is a nonnuclear SDI, there is no such requirement on the Soviet Union. We need to understand what concepts they may have already developed, what concepts they may be pursuing that would pose a threat to our own strategic defense initiative and may constitute a threat to our own offensive forces.

I have mentioned now three categories under this overall category of weapons development—weapons developed for specific U.S. weapon systems; tests to develop new concepts which may be applicable to future, undefined weapon systems; and the category of basically understanding what may be possible, whether or not the United States intends to deploy it.

I want to return to the first of those categories for a moment to amplify on the concept of modernization.

In many people's minds, modernization seems to be a dirty word. I want to point out that the weapon systems, the so-called modernization that has taken place in the U.S. nuclear weapons inventory, constitute designs which have made our deterrent more survivable, which have restored its capability in the face of Soviet steps which have tended to erode our deterrent.

The Soviet steps that have tended to erode our deterrent sort of fall into two categories.

One, they have taken steps which have threatened the survivability of our deterrent. The Soviet air defense improvements have caused us to come to the conclusion that the B-52 either now or in the very near future, is not a credible penetrating aircraft.

We have taken two steps to restore a deterrent that already existed. One is to produce the B-1 bomber, which we believe can penetrate Soviet air defense. The other is to pursue the concept of standoff cruise missiles.

I want to point out that it is new nuclear weapons designs that made the B-1 bomber a credible element of the deterrent. Delivery characteristics of a B-1 bomber that allow it to penetrate are very, very different from those of a B-52. The aircraft flies at lower altitude, higher speed, and, therefore, the weapons that are dropped from that aircraft are going to be subjected to much higher shock environments when those weapons hit the ground.

The weapons that we had developed for the B-52 literally would not survive delivery in the normal delivery pattern of a B-1. So, the B-1 delivery system would not have had any utility had not the nuclear weapons laboratories designed nuclear weapons capable of delivery from that platform.

Similarly, with respect to the Navy's Trident missile, which has a range substantially greater than that of previous submarine missile systems, that missile range was increased for the sole purpose of providing greater survivability for the submarine which delivers the missile. We wanted the submarine to be able to operate in larger ocean areas and, hence, be less susceptible to Soviet antisubmarine warfare tactics.

A longer range missile means the reentry vehicle that carries the warhead will be subjected to much higher heat, higher vibration loads. The warheads that had previously been designed for earlier Navy systems could not have survived the environments of the new Trident missile.

Hence, a new warhead was developed that ultimately made the whole Trident system a credible part of our whole deterrent.

I could go on and on with a list like that. But the point I wanted to make is that the nuclear weapons, the modernized nuclear weapons, are an integral part of our modernized deterrent. The modernization process of our deterrent has been made necessary by threats to the existing deterrent from the Soviet Union. It is new nuclear weapons that have made our responses credible, that have restored a deterrent which has eroded because of steps taken by the Soviets.

Let me make a final point that those steps are not necessarily nuclear-weapons-related steps on the part of the Soviet Union. The Soviet air defenses that caused us to go to the B-1 bomber are not necessarily nuclear. It was enhancement in conventional air defense capabilities that drove us to that bomber, that drove us to a modernized nuclear weapon.

In the same sense with respect to the Trident missile, it was not Soviet nuclear weapons development that caused us to deploy Trident. It was concern about Soviet conventional anti-submarine warfare capabilities.

I want now to turn to the fourth category of nuclear tests, the physics tests.

"Physics tests" I think is a jargon of the nuclear weapons laboratories. What it basically means is the category of tests that are designed to better understand the fundamental physics of a nuclear weapon, what makes a nuclear weapon do what it does.

Time and time again, the scientists at our nuclear weapon laboratories are surprised. They find out that their calculations, despite the fact that they have the biggest and best computers that we can offer, are wrong, that they make mistakes, that these computers do not tell the absolute truth when it comes down to a real test.

This attempt to understand the fundamental physics better may, at some time in the future, reduce the dependence upon testing. But, at the current time, we are dependent upon tests and we need to better understand the fundamental physics.

That is what this fourth category of nuclear testing is about.

I have summarized the four categories of nuclear tests for you. I want to make the point that each of them is equally related to the continued credibility and maintenance of our deterrent, because every single one of those tests contributes to the competence and credibility of the engineers and scientists we turn to to ask whether our deterrent is still reliable, whether our nuclear weapons will still work.

The only reason why we should trust that judgment is because several times a year their feet are held to the fire. When they design a weapon, when they design a nuclear device, that design is tested. That test record is what gives us faith in their credibility.

The other area of technical issue I wanted to address was verification.

I think it has already been touched on fairly well by Ambassador Holmes. I would be happy to answer questions later on about the Corrtex system if there should be a desire to address that system in any detail.

It is the basis upon which the President has said if the Soviets can agree, will agree to verification measures based upon Corrtex or a similar technology that would offer comparable accuracy, that he is ready to move forward on ratification of the Threshold Test Ban Trea'y and the Peaceful Nuclear Explosives Treaty.

The President has indicated that we believe that that Corrtex system has an accuracy of 30 percent. That means that even with Corrtex, we will still have a 30-percent uncertainty in the yield of a test, which is measured by such a device.

But he has made the determination that he is prepared to move forward toward ratification if measures based upon it are adopted.

With respect to the comprehensive test ban, that is a very long and complex issue. I would, again, be happy to address your questions on that matter. I would only want to point out that improved verification is an integral part of the criteria that we have for a comprehensive test ban, any future Comprehensive Test Ban Treaty; that we indeed have an aggressive program of funding research in that area, both through the Department of Energy and the Department of Defense's Defense Advanced Research Projects Agency.

Only one example of that research effort is the very impressive facility that was dedicated in Norway over a year ago, which offers the promise of significant improvements in the detection of seismic signals of very low magnitude.

This is part of a research program, but a research program that the administration is pursuing very aggressively.

With that, I will end my comments and will be prepared to answer questions.

[The prepared statement of Mr. Barker appears in the appendix.]

Senator EVANS. Thank you very much. It was a very interesting presentation.

I must say that there was one most distressing element of that that I heard, and that was when you likened the erosion of nuclear weapons to the erosion which occurs to all of us over time.

I had always thought that the bushy hair we were born with slowly fades away to expose beautiful foreheads, and that lines appear on your face to show the magnificence of character, and that gentle bulges appear to show that we are well sustained and well fed. [Laughter.]

Now you are telling me that I am wrong.

Mr. BARKER. But I like your version better, Senator. [Laughter.]

Senator EVANS. With that, we would like to turn to our third witness, Mr. Richard Perle, Assistant Secretary for International Security Policy, Department of Defense.

Mr. Perle.

STATEMENT OF HON. RICHARD PERLE, ASSISTANT SECRETARY FOR INTERNATIONAL SECURITY POLICY, DEPARTMENT OF DEFENSE

Mr. PERLE. Thank you, Mr. Chairman.

My colleagues, Allen Holmes and Bob Barker, have already covered a great deal of the substance of the issue the committee is considering, so I would like to take advantage of their very excellent presentations by making a few summary points.

I will do so briefly.

The point has been made by both my colleagues that the United States depends for its security and for the security of its allies on nuclear deterrence; that we are likely to continue to depend on nuclear deterrence for the foreseeable future; and that for so long as we do, it will be necessary to maintain a stockpile of nuclear weapons and to test them in order to assure that they are safe, secure, reliable, effective, and survivable.

But, even more than that, I think it is fair to say that the program of nuclear testing that this country has conducted over the years has permitted improvements and alterations in the nature of that nuclear deterrent, and the nuclear stockpile. Our testing program has enabled us vastly to reduce the aggregate yield of our nuclear force and the total number of weapons in our nuclear inventory.

So, today, the United States possesses several thousand fewer nuclear weapons than we had in the 1960's, and the megatonnage of the nuclear weapons we now have deployed is barely a quarter of the megatonnage of our nuclear forces in the 1960's. One of the

reasons why we have been able to reduce both the number and yield of the nuclear weapons that constitute our deterrent and that of our allies is that we have made significant improvements in the weapons we have retained in our smaller residual forces.

Those improvements would not have been possible without nuclear testing.

So, if we had ended nuclear testing in the early 1960's, as was widely advocated, in my judgment, we would today have a significantly larger stockpile of weapons, a less reliable, less safe, and less secure stockpile of weapons, and a stockpile of weapons of vastly greater megatonnage whose use in a war could produce very serious and unnecessary collateral damage, and possibly even other catastrophic consequences.

I think it is worth underlining that the nuclear testing program of the United States, like that of the Soviet Union, entails not only the testing of nuclear devices, but the testing of nonnuclear devices, nonnuclear weapons, systems of communication, command and control and the like, in order to determine whether they will be safe in a nuclear environment, in the sort of nuclear environment that might exist in the course of a possible war. We must, of course, insure the reliability of these systems to prevent or deter any such war. For without an ability to test nonnuclear components with respect to nuclear effects, uncertainty about our systems of communication, our systems of command and control, the effectiveness of our conventional forces would rise to the point where even our nonnuclear defenses would become far less certain and would contribute less to the security of this Nation.

Bob Barker mentioned one of the ways in which the safety of nuclear weapons, has been improved in recent years—the development of insensitive high explosives.

All nuclear weapons require a precursor explosion in order to produce the initial nuclear effect and, until the development of these insensitive high explosives, we had to use in our nuclear weapons explosives of the conventional sort that are vulnerable to detonation by accident.

The world has been reminded in recent days of how serious a nuclear accident can be, in this case a nuclear accident at a civilian power plant.

I think it is remarkable that in the nuclear age, despite the construction of thousands of nuclear weapons, the world has been spared an accident involving the detonation of a nuclear weapon. I find it very difficult to believe, Mr. Chairman, that, had we frozen our nuclear weapon designs, had we stopped incorporating improved safety features in our nuclear inventory early in the history of nuclear weapons, we would be able to look back today and observe that the safety record has been perfect.

If we are to continue to maintain a safe stockpile—and it is certain that we will maintain a stockpile—then, in my judgment, in the judgment of the Department of Energy, in the judgment of those who design and certify the weapons, it is vital that we continue nuclear testing.

I happen to be one of those who believes that the likelihood of a deliberate nuclear war, undertaken as the result of a conscious and deliberate decision to detonate nuclear weapons, is extremely un-

likely, provided that we maintain effective deterrence. It seems to me that we have, therefore, an even more compelling obligation to do everything we can to reduce to the absolute minimum the possibility of a nuclear accident because it seems to me that it is through an accident, rather than through a deliberate act of policy, that a nuclear war could begin. And even if a nuclear war did not begin, the consequences of an accident itself could be catastrophic.

We already have in place a regime regulating the circumstances under which nuclear weapons can be tested. We have for many years not tested in the atmosphere. Although I must say that on dozens of occasions, the Soviet Union has conducted its underground tests in such a way as to permit radioactive material to escape from those underground test locations and even to move across the Soviet border into international territory, which, in our judgment, constitutes a continuing violation of the atmospheric test ban treaty to which the Soviet Union is a party.

We have made repeated protests to the Soviet Union when they have conducted tests of this nature, and those protests, without exception, have not been responded to by the Soviet side.

Since 1974, we have been bound not to test nuclear weapons above the level of 150 kilotons, underground.

This country has complied with that limitation on testing. The evidence strongly suggests that the Soviet Union has not, and that it has, on a number of occasions, exceeded the 150-kiloton threshold, although we cannot state that with certainty because the upper end of the range of uncertainty surrounding our estimate of the yield of Soviet tests by seismic means is on the order of 200 percent. This is to say that a Soviet test could be vastly larger than 150 kilotons and we would be unable to say to you with certainty that that test, even though we believe it likely to have exceeded 150 kilotons, had in fact done so.

It is in part for this reason, this uncertainty concerning the existing threshold limitation and the likelihood that the Soviets have violated it, that the President has proposed that before proceeding to ratify the threshold test ban, we arrange with the Soviets some additional measures of verification that would give us confidence that the Soviets were indeed complying with the 150-kiloton threshold.

As it happens, we have available to us a technology that we think would significantly reduce the uncertainty down to about 30 percent, as Bob Barker has indicated. And we have made a proposal to the Soviets that they permit us, using this technology, to make direct measurements of the yield of their tests by sending technicians to the Soviet test site.

Now, in recent months, we have heard a great deal from the Soviet Union about their interest in improving standards of verification in arms control arrangements between us. This seems to me the ideal test case, because what is involved is a small number of technicians traveling to Soviet nuclear test sites—we have invited the Soviets to come to ours—with equipment that can accomplish only one purpose, and that is the measurement of yield. These are remote locations where there is no conceivable military intelligence to be gathered by the technicians collecting information on yield. And, if the Soviets will not agree to this minimal step, which is not

invading their laboratories, is not examining their missile warheads, but this minimal step of taking measurements of the yield of their nuclear tests, then I think this raises very serious questions about the Soviet claim to a new interest in verification.

So, for political as well as technical reasons, we think it important to press this initiative.

Unfortunately, a number of congressional actions, past and pending, by calling on the administration to proceed to ratify the threshold test ban without an improvement in verification, will discourage the Soviets from responding positively to this initiative.

I feel bound to say to the committee that in adopting language like the language in Senate Joint Resolution 252, or the language in House Joint Resolution 3, you are undermining inevitably the effort by this administration to persuade the Soviets to agree to an improved verification regime with respect to the existing arrangements limiting testing to 150 kilotons.

As our negotiators sit, or attempt to sit at the table with the Soviets, proposing that we ratify only with improved verification, there is, playing in the background, a song composed in the House and perhaps in the Senate that says it is not necessary to agree to improved verification because the Congress of the United States is urging the President to abandon his proposal for improved verification and ratify the threshold test ban as it stands with all its difficulties and problems.

I would comment, Mr. Chairman, on the related agreement of the mid-1970's, having to do with peaceful nuclear explosions, only by observing that it represents an enormous loophole should the Soviets be interested in clandestine testing.

This is because our ability to verify Soviet nuclear weapons tests, even if we could go to their nuclear weapons test sites, would not extend to sending our technicians to areas where the Soviets might claim that the tests they were conducting were peaceful tests.

So I think we would have to think hard about how to capture this very important loophole, this avenue for possible violations, if we were to obtain an agreement to an improved verification regime at the 150-kiloton threshold.

Finally, let me conclude by being as clear as I possibly can.

While the administration believes that in the very long term—in a world in which nuclear weapons play a vastly diminished role in the security of the United States and its allies—it might be safe to run the risks associated with a comprehensive ban on nuclear testing, we believe that it would be irresponsible and unwise to enter into such an agreement at this time. It makes sense in the distant future—at a time when we do not need to depend on nuclear deterrence to ensure international security and stability. But that is sufficiently distant so that, I believe it is unwise for us even to discuss with the Soviets at this point a comprehensive ban on nuclear testing.

Under a CTB, we would be trading the safety, security, and survivability of the existing nuclear forces upon which we depend for our security for the uncertainty, the lack of safety, the lack of reliability that would inevitably develop in the forces that we would be compelled to continue to maintain as our fundamental nuclear deterrent.

This seems to me an issue whose time has not come. We would very much hope that the committee, in its deliberations, would consider not urging a policy totally different from that which the administration has on the table or is attempting to put on the table in negotiations with the Soviets but would, instead, content itself with the expressions, the sentiments found in Senate Concurrent Resolution 135, which supports the President, while the other legislation to which I have referred, so clearly undermines him.

Thank you, Mr. Chairman.

Senator EVANS. Thank you very much, Mr. Perle.

We will limit this round of questioning to 10 minutes each.

I am not sure whether I will necessarily specify each question to a particular individual. While I may address it to an individual, if any of the other witnesses has a comment on a particular question, please feel free to speak up.

Let me start with Mr. Holmes.

I don't know whether or not my memory is accurate, and this really relates to a time before I was on this committee or even in the Congress, but over the past decade or so, as controversy has raged over the question of a comprehensive test ban, all of the opposition seems to have focused on verifiability. It is only relatively recently, I believe, that much of the argument seems to have shifted away from the question of verification toward one of reliability and the need for continued testing, which has been expressed here this morning, for so many other circumstances.

Does my memory serve me well as to where the arguments have been over the last 10 or 15 years?

Maybe other panelists can comment on that, as well.

Ambassador HOLMES. Mr. Chairman, I have been associated with this policy just over the last year and I don't have the corporate memory that perhaps some of my colleagues have.

But I believe that the question of verification and the other questions concerning the reliability and effectiveness of nuclear weapons have been forwarded as arguments over a number of years.

But as to the emphasis among these, I am not able to comment.

Senator EVANS. Mr. Perle I am sure has a long corporate memory.

Mr. PERLE. Yes, I remember the issue for a long time.

I think your observation is correct, that in the public debate on this issue, the inability to verify a comprehensive test ban has been the single most prominent argument advanced by the opponents.

I think this is true for a number of reasons. One is the belief that if you cannot verify it, that is such a show stopper that it is hardly worth detailing the other disadvantages that would enter into such an agreement.

But, second, I think that the experts, for example, the people who are legally responsible for certifying the safety and security of weapons, have always had in mind the immense complications that a ban on testing would have for their work and their responsibilities.

But this has not been at the forefront of the public debate. The public debate has been vastly oversimplified, if I may say so, and this administration has gone out of its way to stress what we think are the more fundamental and underlying reasons.

This leads us to the conclusion that, even if we could verify compliance with a comprehensive test ban at this point, it would not be in our interest or the interest of the world to undertake such a ban.

We have no interest in the Soviets having unsafe weapons, just as we have no interest in the Soviets having unsafe conventional nuclear powerplants.

Even if we were unable, for some reason, to test our own weapons, I would hope that the Soviets would test theirs sufficiently to be sure that they are safe.

Senator EVANS. It seems to me, then, we could accurately summarize that by saying if we were assured of verification ability, very likely with onsite inspection of some sort, the administration would then proceed or would advocate proceeding with ratification of the Threshold Test Ban Treaty and the Peaceful Nuclear Explosion Treaty, but that, regardless of verification, it would be unwise at any time in the foreseeable future, at least, to proceed with a comprehensive test ban. Is that accurate?

Mr. PERLE. That's correct.

Ambassador HOLMES. Yes, sir.

Senator EVANS. Let me continue with Mr. Holmes, or Dr. Baker may answer—whoever wishes to do so.

You mentioned the likely violation of the 150-kiloton threshold. And yet, we talk about our inability to verify with remote sensors and remote locations the difficulty of being accurate.

How certain are we? We say "likely," but that is an adjective of uncertainty. How likely do we think that it is? Is it just as likely that we overestimate the kilotonnage of their tests as underestimate them?

Could you enlighten me on that?

Ambassador HOLMES. Yes, Mr. Chairman.

We have some evidence that the Soviets have conducted tests close to the 150-kiloton yield ceiling. And, given the fact that with our teleseismic system of evaluating the yield, for example, a yield, a central average yield of 150 kilotons, we could be off as much as, well, it could be 300 or it could be 75. Therefore, we cannot say with certainty that there has been a violation.

But, given the high yield of some of these tests, it is likely that, in fact, they have violated.

Perhaps Dr. Barker can elaborate.

Mr. BARKER. We are dealing with a statistical situation, whenever you say you have a large uncertainty in something.

If the Soviets were to conduct a test program of 20 tests exactly at 150 kilotons, you would expect half of those tests to have recorded yields above 150 and half below 150. If the President's proposal of Corrtex were adopted, to which he associates an uncertainty of 30 percent, we still might expect to see measurements with that device having yields as high as 150 plus 30 percent of 150, which means as high as 195. Or even in a worst situation right now, with the kind of uncertainty that Ambassador Holmes just mentioned, when you look at the number of Soviet tests which provide us with estimated yields, for which we estimate that the yield is above 150, that number is large, uncomfortably large. When you combine that seismic data with other information which is of a more sensitive

nature, the President, in studying the totality of that data, came to the conclusion that the Soviets were in likely violation but, at the same time, because of the very, very disappointing verification capabilities, had to admit to there being some uncertainty associated with that judgment.

Senator EVANS. Are you able to say in an open hearing whether our testing has occasionally been close to or at the 150 kiloton level? Have we gone up close to that level?

Mr. BARKER. All of our testing has been consistent with the obligation not to test above 150 kilotons. But we have indeed tested close to that level.

I think a part of this whole verification issue that is forgotten is the fact that the Soviets have routinely approached us since the Threshold Test Ban Treaty was signed, questioning whether we have exceeded that threshold.

We have not. Clearly they have verification problems, too, which, in a logical sense, provides all the more incentive for them to want to work with us to provide a method of verification for the Threshold Test Ban Treaty, which can provide both of us with the kind of confidence that arms control is supposed to provide.

Senator EVANS. You mentioned that on numerous occasions there has been venting of radioactive material into the atmosphere which has crossed Soviet boundaries and which, presumably, we have detected.

Do you have any more specific information on what "numerous" means?

Mr. BARKER. I think "numerous" means the point where it is now routine; that in any given year, it is likely that on more than one occasion, and in fact in many years on several occasions, we will detect radioactivity outside the boundaries of the Soviet Union.

These are not necessarily large amounts of radioactivity. But we have the standard of Glenn Seaborg who, when he was Chairman of the Atomic Energy Commission, testified as to what the standard for compliance would be for the Limited Test Ban Treaty, when he urged the Senate to ratify it.

At that time, he indicated that our standard should be that if we can detect it, detectable radiation constitutes a violation. We have, ever since that treaty has been signed, detected radiation from Soviet events outside Soviet borders.

I am very surprised—and this is an area of my own ignorance—that over the last several weeks, I think the last week, really, we have all been very aware of the fact of the degree of sensitive instruments that exist throughout the world for the detection of radiation. I cannot help but believe that there are many other nations that are in the same position we are, to detect this Soviet venting.

In the future, when we detect it, I would hope that we would encourage other states to make measurements of their own to make sure that it is not just we who have a concern in this area.

Mr. PERLE. Mr. Chairman, if I may say so, there are numerous occasions—I think it approaches 100—in which we detected illegal Soviet venting. We protested to the Soviet Union many times over the years. We did so in secret. I think that is a great mistake.

I think one of the reasons why the Soviets have been as cavalier as they have about venting radioactive material into the atmos-

phere is that it has been kept secret from the countries involved, including this one. All they need to do to avoid that is to invest a little bit more in digging holes a little bit deeper.

But they have not been prepared to endure that marginal additional expense in order to comply strictly with the terms of the treaty.

Mr. BARKER. I would only add that it is an expense that we have, indeed, undertaken, and for the last 10 years, better than 10 years, have had no cases in which we have even had radioactivity identifiable outside the boundaries of our own test site.

Senator EVANS. Thank you.

Senator Pell.

Senator PELL. Thank you, Mr. Chairman.

Mr. Holmes, what would be the circumstances under which you could support a fixed moratorium, a mutual moratorium, with a time limit fixed by the President?

Ambassador HOLMES. Senator, as long as we rely on having an inventory of effective nuclear weapons to secure our strategic deterrence, we don't really foresee in this context the possibility of joining a moratorium.

Senator PELL. To pursue that thought, doesn't it mean for the indefinite future, or forever, because the only way you are going to get away from them is if you eventually reach an agreement of this sort?

Ambassador HOLMES. I wouldn't say forever.

Our view is that we believe in a comprehensive test ban which, in fact, would be tantamount to a verified moratorium as a long-range goal. But we would prefer to pursue that in parallel with the pursuit of the comprehensive elimination of nuclear weapons, which is a goal that has been now made public by the President. Until we reach that goal, we will have to rely, to some degree, on nuclear weapons.

Therefore, we would not be in favor of a moratorium until that day arrives.

Senator PELL. That is a rather desolate thought, I think.

Dr. Barker, did you have a comment?

Mr. BARKER. Senator Pell, when the word "moratorium" is used, I must admit that, personally, my hackles start to rise, only because to me, a moratorium is a Comprehensive Test Ban Treaty without any semblance of verification associated with it.

I wonder if I am misunderstanding the context in which you discuss a moratorium.

I know of your long history of interest in the whole arms control process, and I think I understand that what we hope to get from arms control is increased confidence in a stable world. In my view, my work in verification leads me to the conclusion that we can only have that confidence if we can verify very effectively every arms control treaty to which we are a party.

So, while we can debate and discuss the appropriate timing of a comprehensive test ban, I view a moratorium as a much more dangerous thing because it would seem to signal that we are less concerned about verification than we ought to be if we are to be concerned about having confidence in the arms control process.

Senator PELL. Speaking of verification—and this is rather specific detail, but you are a specialist in the subject—how can one ever verify the cruise missile, whether it has a nuclear or a conventional warhead?

Mr. BARKER. I know of no way to make that determination in a confident way.

Senator PELL. If there is no way of ever verifying it, then doesn't that mean an indefinite reliance on nuclear weapons?

Mr. BARKER. I think verifying that all nuclear weapons have been removed from the face of the Earth is going to be a very difficult job.

Senator PELL. So, in other words—and I don't mean to put thoughts into your mouth—are you saying that we will probably have, indefinitely, nuclear weapons in the arsenals of the various nations?

Mr. BARKER. I will admit that, personally, I expect to live my life in a world in which nuclear deterrence is a major part of the mechanism which has maintained stability in the world.

We have come to grips with that reality. I think that the world is a relatively stable place under the current circumstances, and that as long as the United States maintains its commitment to maintaining its part of this mutual deterrent, we will, indeed, be in a safe and stable world. We may hope to be able to replace that with a defense emphasis deterrence, one in which we can protect ourselves and our allies from nuclear weapons, and that may be the most critical step to the ultimate elimination of nuclear weapons, the fact that they may no longer be perceived to have any military utility.

Senator PELL. Would you repeat that last sentence, please.

Mr. BARKER. I said the elimination of nuclear weapons I think will only come when they are perceived to no longer have any military utility.

Senator PELL. Is that a backdoor approach to stressing the SDI?

Mr. BARKER. It was not my intention to stress SDI, Senator.

Senator PELL. Well, then, if it is impossible to verify cruise missiles, how can they ever be taken out of the arsenal? It will have to involve the element of trust.

Mr. BARKER. I think it will also require a tremendous openness in the societies that currently have nuclear weapons, a degree of openness that is certainly beyond anything which currently exists in the Soviet Union.

I suspect you would agree with me that if we, the United States, said that we had eliminated all nuclear weapons, it would be very difficult for anyone to retain a nuclear weapon. If we ever got to the day when we had the same degree of openness in the Soviet Union, we could also believe such a statement then.

Senator PELL. What would be your thoughts in this subject, Mr. Perle?

Mr. PERLE. I think in this latter exchange, you have gotten down to the critical point, which is, can we anticipate a political change that would so alter the circumstances in which we maintain nuclear forces as to bring some hope back into what you described as a desolate future.

We could easily agree with the United Kingdom and France, both of which possess nuclear weapons, that the three of us, together, would eliminate those weapons, and I think we would have sufficient confidence in compliance by the United Kingdom and France, and they in compliance by us, to make an agreement possible, even though there would be some residual inability to verify that.

If the Soviet Union evolves along lines that make them as reliable a partner as the British or the French, then things that are not now possible might become possible.

Senator PELL. I guess I am puzzled, because as I see it here, there is a real dilemma. On the one hand, the President has set an objective of a world with no nuclear weapons. On the other hand, you gentlemen, who really are responsible for implementing this view, say that it is not verifiable and, without verification, you believe we should depend upon the nuclear arsenal.

I don't quite see how you square the circle here.

Mr. BARKER. I think we have begun that process in Geneva, today, now that talks have resumed. It is our objective to achieve substantial reductions in intermediate range nuclear forces.

Clearly, the process of getting zero nuclear weapons is to start with some reductions. I think Ambassador Holmes can address the process, the degree of receptiveness on the part of the Soviets, better than I in that regard. But I think Richard captured it very, very well.

As we reduce the numbers of nuclear weapons in the world, when you get down to the end of the process, you clearly have to envision an environment in which the Soviet Union has accepted the same degree of openness as a society that we live with today in the United States.

Senator PELL. So what you are really saying is that as long as they have their closed, authoritarian society, or their totalitarian society, there can be no real arms control and no elimination of the nuclear weapons.

Mr. BARKER. I didn't want to say that, Senator.

Senator PELL. I know you didn't want to, but isn't that what you mean?

Mr. BARKER. No.

I think that perfect verification, as we both realize, is impossible. You always have some degree of uncertainty. There are two questions. One is whether that degree of uncertainty poses a military threat, whether, within that degree of uncertainty, there is a military threat that is unacceptable; or, whether, within that degree of uncertainty there is a threat to the arms control process, namely, the verification is so bad we will continue to pick up signals of potential noncompliance that will cause us to doubt the validity of the treaty.

So there is lots of room for arms control before we get to the point of having to verify zero nuclear weapons in the world.

Senator PELL. Thank you very much.

Thank you, Mr. Chairman.

Senator EVANS. Thank you.

Senator Kassebaum.

Senator KASSEBAUM. Thank you.

I would like to follow up on a question that Senator Evans raised regarding the 150-kiloton limit.

In April, it was reported that the CIA had changed its procedure for estimating the yield of large Soviet nuclear tests, because it was believed, perhaps, that the procedure we had been following had overestimated the yield of those tests.

Has this changed procedure in any way affected the administration's thinking regarding violations of the Threshold Test Ban Treaty?

Mr. BARKER. Let me clarify that the procedure has not changed.

Ever since we signed the Threshold Test Ban Treaty, we have been dependent upon seismic signals for estimating the size of Soviet tests.

What has happened since 1974 is that several times we have changed some numbers in the formula that we use to estimate the yield associated with a particular-sized seismic signal.

We consult with academic seismologists routinely over the course of time, and since 1974, I think the formula may have changed as many as three or four times, as they have come to believe that they know better how to make such estimates.

While the numbers in the formula were only changed in April, the technical basis for that change, all the technical information that led to the change, was available to the people who worked on the President's compliance report that was presented to the Congress in December 1985.

So, all the information that was available was available last fall and was fully folded into the conclusions reached by the President, so that when the President said in December, 1985, that the Soviets were in likely violation of the treaty, he did so with full knowledge of the advice of the seismic panel.

So, the short answer is no, the change in formula does not change the conclusion of likely violation.

What it does is, it reduces somewhat the number of events that appear to be likely violations.

Senator KASSEBAUM. What channels have we gone through to register our concerns about these violations?

Have we raised this with the Soviets in such a manner that there has been any particular, useful exchange?

Ambassador HOLMES. We have raised, Senator, these likely violations with the Soviets through diplomatic channels, and we have not received satisfactory responses.

Senator KASSEBAUM. It seems to me that at this juncture, our course has to be to try to find constructive, small steps to build on.

You said, Dr. Barker, that if the Soviets would agree to the Correx verification regarding the threshold test ban, that the President has said that he would move forward and would sign.

Would you agree with that, Mr. Perle, that that is adequate verification?

Mr. PERLE. Yes. That would sufficiently reduce the uncertainty, and it would be a demonstration of Soviet willingness to cooperate. That has a political dimension. On that basis, I think it would be wise to ratify the threshold test ban.

We are observing it anyway, unilaterally.

Senator KASSEBAUM. When we asked them to come to Nevada to observe the Corrtex system and the test, did they respond at all, or did they just not come?

Ambassador HOLMES. They have never formally turned us down. But, they did not come to the test that we invited them to last month.

Senator KASSEBAUM. So they just didn't respond at all?

Ambassador HOLMES. Well, they have responded by repeating their offer to extend the moratorium, and asking us to join it. That, basically, has been their response.

Senator KASSEBAUM. Well, have we tried really to explore with them what their thoughts are on the Corrtex system? Have we explained it to them?

Have we done this through some scientific channels?

Mr. BARKER. We would love to, Senator, although we have every reason to believe that they do understand some of the fundamental aspects of this technology.

Between 1974 and 1976, we conducted extensive technical discussions in conjunction with formulating the verification provisions for the Peaceful Nuclear Explosives Treaty. One of the verification measures that we proposed to use to verify compliance with the Peaceful Nuclear Explosives Treaty was a technical device very similar to this Corrtex device that we are talking about now.

There have been some technical changes that we think make it better. So, we have already established the technical basis for detailed technical discussions with the Soviets. We have asked them to send technical people to discuss these issues with our technical people for the last 2 or 3 years, and have just run into a stone wall.

Mr. PERLE. We did, on one occasion some weeks ago, have a conversation with a Soviet official talking to an American official, that looked as though it might be the first faint opening in this area. This was followed a very few days later by the passage of House Joint Resolution 3. We have heard nothing more since. However, I wish to point out that in a speech at Togliatt on April 8, 1986, Mr. Gorbachev, referring to the President's initiative, stated: "We, naturally, have not accepted it, and will not accept it."

I believe, Senator Kassebaum, that a reiteration by the Congress of a call on the President to proceed without this improved verification will mean the end of any hope that we might persuade the Soviets to discuss this issue with us.

Senator KASSEBAUM. Mr. Gorbachev said at Geneva, did he not, that he would allow onsite inspection in the Soviet Union?

Is that accurate?

What did we do to follow up on that?

Mr. PERLE. On a number of occasions, we and other Soviet officials as well, have talked about onsite inspection in the abstract.

Generally, it turns out to mean, and in the instant case it means that if we agreed to a comprehensive test ban, then some sort of unspecified, onsite inspection would be permitted, in the words of Mr. Gorbachev, "when necessary." This is not a new Soviet position on onsite inspections, but one they have taken at least since 1958. Historically, the Soviets have insisted on the right to veto any inspection request, thus reserving for themselves the right to decide when an inspection on their territory is necessary.

We know of no way to use onsite inspection effectively to verify compliance with a comprehensive test ban since a test could take place anywhere, in the Soviet Union or elsewhere.

Senator KASSEBAUM. So they have tied it to a comprehensive test ban?

Mr. PERLE. That's right.

Senator KASSEBAUM. Did he do that at Geneva?

Mr. PERLE. They have been very vague about what sort of onsite inspection and under what circumstances.

Frequently, the Soviets argue for what they call "voluntary" onsite inspection; that is, the side that wishes not to be inspected is not obliged to be inspected.

And, in other instances, when we have probed what they mean by "onsite inspection," they mean that we can send observers long enough to observe the dismantlement of things that have to be dismantled, and then the observers go home.

So, we have yet to see an expression from the Soviets of support for on-site inspection of the kind that I think you and I would agree would constitute an important step forward.

The onsite inspection that we are proposing to verify the 150-kiloton threshold, precisely because it takes place in remote areas, where there are no installations of military significance, is the least intrusive sort of inspection that one can imagine. That is why we are hopeful that we can eventually persuade the Soviets.

It takes time to agree to this.

Senator KASSEBAUM. Let me get back to the Corrtex for just a moment.

Will this be raised at the current negotiations?

It seems to me that this is something we could really press forward, to see if there might be some meeting of the minds on this.

Ambassador HOLMES. Which current negotiations are you referring to, Senator?

Senator KASSEBAUM. I don't know exactly what is going on at Geneva myself. I would assume that we have the full agenda, do we not?

Ambassador HOLMES. We do, but we don't discuss nuclear testing in the Geneva negotiations that resume today. But we have, through diplomatic channels, continued to press them on the President's offer to use the Corrtex hydrodynamic system. He has suggested, again, that our experts get together and discuss how we might verify a test using this equipment.

I think it is well to point out that prior to this particular offer, we did not insist on the Corrtex system. We made a unilateral offer to them to bring their own instruments to calibrate, to observe a test at the Nevada test site and to learn something about the geology of that test bed.

Senator KASSEBAUM. My time is up.

I am still curious about exactly how we make this approach to them.

Thank you.

Mr. PERLE. If I could just add, Senator, we would very much welcome an expression by the Senate of support for this approach. I think it would give it additional weight and improve the prospects that the Soviets might respond.

When Allen talks about "diplomatic channels," he has in mind a variety of levels, including the President corresponding directly with Secretary Gorbachev.

Senator KASSEBAUM. Thank you.

Senator EVANS. Senator Kerry.

Senator KERRY. Thank you, Mr. Chairman.

Senator EVANS. First, I might note that Admiral Crowe has arrived. We will still retain up to ten minutes for each Senator, but if anyone chooses not to use the full 10 minutes, it will aid us in the process.

Senator Kerry.

Senator KERRY. Is that a Chairman's hint?

Senator EVANS. Only a hint.

It is not verifiable.

Senator KERRY. It's not enforceable, you mean.

Senator EVANS. Yes. [Laughter]

Senator KERRY. Mr. Secretary Perle, I heard your comments when I was in the next room. I think I heard you say that you perceived that an accident was the most critical potential that you feared would start some kind of conflict.

I understood you also to say that the reason we cannot move forward with a comprehensive test ban is that we need to insure that our systems are safe, secure, and survivable.

What does the x-ray bomb have to do with any of those criteria—accident, safe, secure, or survivable?

Mr. PERLE. I'm not sure precisely what you are referring to.

If you are referring to devices that would power an x-ray laser—

Senator KERRY. Well, we are currently researching and experimenting with a nuclear explosion that is, in fact, trying to harness x-rays into the potential of a weapon system. That requires a nuclear explosion, a nuclear test, a new weapon system.

I am asking what does that have to do with any of the criteria that you have asserted as the reasons for our testing?

Mr. PERLE. As you know, we believe that the deployment of a strategic defense would go a long way toward making our retaliatory forces more survivable.

Senator KERRY. So, in point of fact, there is an additional reason that we are testing. It is not simply for safety, security, and survivability. It is also because we are on a course to design a new weapon system.

Mr. PERLE. Oh, absolutely.

Senator KERRY. And that is clear.

Mr. PERLE. I certainly did not mean to obscure that.

Senator KERRY. Then let me come back to the issue of safety and survivability.

Mr. BARKER. Senator, could I add to that, please?

Senator KERRY. Absolutely.

Mr. BARKER. I went through a litany of what the U.S. nuclear test program is about, and I wanted to point out that the x-ray laser program has a twofold purpose.

One of our responsibilities is to understand the potential threat the Soviets might pose to both our offensive systems and to any potential nonnuclear SDI that we might deploy. Clearly, an x-ray

laser, if it turns out to be a feasible weapon, is something the Soviets could deploy either against our own offensive forces or against a nonnuclear defense.

Senator KERRY. Well, with a comprehensive test ban, they would be unable to test nuclear lasers.

Now, would we be better off with them not testing it as well as us?

Mr. BARKER. You are making the assumption that they have not already done some nuclear testing——

Senator KERRY. Have they done it? Have they tested an x-ray laser?

Mr. BARKER. We do not know enough about the details of the Soviet nuclear program to make a positive statement in that regard.

Senator KERRY. So, this is kind of a catch 22. What you are really telling us is that we can never have a comprehensive test ban.

Mr. BARKER. There are conditions under which a comprehensive test ban is possible. As long as we depend upon nuclear tests for the reliability of existing nuclear weapons, nuclear testing seems to be appropriate. At a time when nuclear weapons no longer exist, clearly there is no need for nuclear testing.

Senator KERRY. That sounds like a catch 22 to me.

Have you ever instructed, has anyone ever instructed our labs to design nuclear weapons with specific emphasis on reliability, specifically specifying a reliability which can be assured through non-nuclear testing?

Has that ever entered anybody's mind?

Mr. BARKER. I believe, Senator, that the nuclear designs that have been produced by our laboratories for the last 30 years, if you ask the designers who designed those particular weapons, they will tell you that they have designed them to be as reliable as they know how to make them at any given time. They certainly have not designed them to intentionally have flaws in them, and they have designed them to last as long as the system they were designed for would last.

The problem has been that we have plenty of evidence that, despite their brilliance, despite their very elaborate computers, they have made mistakes. They have erred in their judgment that they have designed a reliable weapon, and we have found drastic errors after the system has been deployed that have required nuclear testing to fix the problem.

Senator KERRY. But, in point of fact, most of the people that I have talked to at Los Alamos and other laboratories would assert that subcomponents can be tested to such a degree that you can test the reliability and workability right up to the point of, but absent, the nuclear explosion itself.

Mr. BARKER. That is true in most situations.

In fact, that is what we do routinely. Routinely, we tear down old weapons, ask the scientists to look at them and make a determination whether things are all right. They do test on a laboratory bench every component they can possibly test, exactly as you said, up to the point of a nuclear detonation.

However, there have been documented times in history where, upon examining a nuclear device, they have discovered a change of a magnitude such that it causes them to question whether the weapon would produce the nuclear yield that it was designed to produce, and only a nuclear test has resolved that problem.

Mr. PERLE. Moreover, Senator, if I might add, there would have been no evolution of the weapons and, therefore, no incorporation of the safety features that distinguish today's weapons from the weapons of 20 years ago, had we been unable to test the weapons themselves.

Component testing alone would not have permitted the evolution of safety features that we think make the force substantially safer.

Senator KERRY. I have two questions on that line.

Question No. 1: again, reliability, however, has never been the first criterion, has it? It has always been yield, size, accuracy. Reliability has never been a criterion which we have set out as number one, as the first priority?

Mr. BARKER. I think that the right people to address that question to are probably in the Department of Energy.

But my recollection—and I will admit to possible error—here is that reliability has always been one of the criteria, and I don't think it has been prioritized as "this is No. 1." But there is a list of important elements that the designers are asked to produce, and one of those elements is a reliable system.

One of the things that they certify to is that we are producing a design which will last twenty years or 25 years, whatever the particular lifetime of the system may be.

The only problem is that they are sometimes wrong.

Senator KERRY. Well, you have all asserted, again and again, the notion of safety, that we would not have gotten so safe if we had not done what we have done.

I absolutely agree. We certainly have improved weapons in certain respects. There is no question about that—both in accuracy, yield, safety, et cetera.

Frankly, I don't think we have changed deterrence one iota. But we have changed the weapon systems themselves.

But the question I want to ask is this. You all have asserted that we need to continue testing in order to maintain the safety, or to achieve safety.

Are you saying that the system today is not safe?

Mr. BARKER. The system today is as safe as we knew how to build the designs at the time they went into the stockpile. The U.S. stockpile has many systems that have been deployed for 20 years, and some are even as old as 30 years.

Should those systems be replaced, be modernized, their replacements would incorporate all of the safety and security features that have been invented in the interim.

Senator KERRY. The point is safety measures are restraints. Safety measures are failsafe, or permission action links, or whatever type of interceding steps you take to prevent a detonation.

Mr. BARKER. Yes.

Senator KERRY. But that is not really what we are testing today. We are testing greater yield, lesser yield, different accuracies.

Mr. PERLE. But I think that is not a comprehensive way to put it.

The improvements in safety have resulted from the evolution of the weapons themselves.

You do not design an unsafe weapon and then test it for safety. You try to design a weapon that is safer.

You asked about the priority earlier. I would be glad to put into the record a letter dated January 21, to your colleague in the House, Congressman Markey, in which the criteria are set out. First among them is nuclear safety.

[The information referred to appears in the appendix.]

Senator KERRY. I have that letter right here.

Is that the same letter which asserted—is that Dyer's letter or a different letter?

Mr. PERLE. This is a letter signed by Frank Gaffney.

Senator KERRY. That is a different letter.

Mr. PERLE. But safety always has been first, and we have been able to incorporate safety features in weapons developed recently that it was not possible to build into the weapons of 20 and 30 years ago.

Now, as we modernize the force, we are constantly looking for ways to make the force still safer and reduce the likelihood of an accident even more.

Senator KERRY. In answer to my colleague, Senator Pell, I heard someone say something about the moratorium equalling essentially a test ban without verification.

Mr. BARKER. That was my statement. Yes, sir.

Senator KERRY. You never asserted at any time during the moratorium that the Soviets tested, did you?

Mr. BARKER. Was there a need to?

Senator KERRY. During the time of the Soviet moratorium on testing, you never asserted, the administration never said they tested, did you?

Mr. BARKER. No.

The administration made no such statement.

Senator KERRY. And, in fact, in briefings with us on the Hill, we have constantly been told that they haven't tested. Isn't that accurate?

Mr. BARKER. I don't know, Senator.

Senator KERRY. Well, I can tell you that we have been told such.

My question to you is how can we be told that by the Defense Department, the CIA, the arms control people, if we are not able to verify it?

Mr. PERLE. I think they were careless if they made that blanket statement.

Senator KERRY. They were "careless" to tell us that?

Mr. PERLE. I don't think anyone was in a position to say that during the period of the moratorium, the Soviets did not conduct any nuclear tests, no matter how long the yield.

Senator KERRY. If the Corrtex system were to be accepted, would you tell us that we should ratify the Threshold Test Ban Treaty?

Mr. PERLE. Yes.

Senator KERRY. You would.

Thank you.

Senator EVANS. Senator Pressler, I should remind my colleagues that Admiral Crowe is here and he must leave before noon. So, in

order to get his testimony, we will have to try to limit the questioning, unfortunately.

The record will remain open for the remainder of the day for any further questions that you may wish to submit to this panel in writing.

Senator Pressler.

Senator PRESSLER. Mr. Chairman, I ask unanimous consent to insert a statement in the record in support of Donald F. Lehman, as the U.S. negotiator for strategic nuclear arms.

Senator EVANS. Without objection, it will be entered into the record.

[The information referred to appears in the appendix.]

Senator PRESSLER. I would like to address a question to the panel about the nature of the Soviet offer, or supposed offer, for onsite inspection. I think Senator Kassebaum has covered that to some extent.

In the past, I have advocated ratification of the Threshold Test Ban and Peaceful Nuclear Explosive Treaties, and, indeed, have had an article in the Washington Post 4 years ago advocating that.

But I believe two things have occurred that should cause us to consider supporting the administration's position that additional verification measures should be negotiated and added to those treaties before we move toward their ratification.

One of those is, very frankly, the Chernobyl powerplant accident and the unwillingness of the Soviets to provide open, honest communication on that. I think it reflects their hesitancy about onsite inspection and indeed, even at the risk of lives of people in their own country and elsewhere.

The second thing that has been raised is their lack of response to the Corrtex verification technology offer.

Some years ago, I had the chance to meet with Viktor Karpov in Moscow, and he said that onsite inspection was just around the corner, or that we were on the brink of it.

How do we get this inconsistency resolved, the inconsistency we see at Chernobyl and on the Corrtex thing?

It seems that from those two examples, the Soviets are just unwilling to enter into onsite inspection. But yet, a lot of the verbiage, or at least the verbiage that I have been given is such that they keep claiming that they are willing.

Mr. PERLE. Senator, if I may say so, I believe that the best way to put the Soviets to the test is for the entire country to get behind the sort of position we have developed—that is, we are prepared to ratify the Threshold Test Ban Treaty with an improved verification regime in which Corrtex would be the central feature. A strong statement of support for that position by the Congress would remove one obstacle to serious negotiation with the Soviets the mistaken belief that the Congress and the Executive are divided and, therefore, they can afford not to respond without any serious political repercussions.

So, we would greatly welcome a statement of support for the approach we have taken.

Senator PRESSLER. Is the Chernobyl nuclear power plant disaster a relevant example of the Soviet attitude on this whole thing, or is it a little irrelevant?

Mr. PERLE. I think the secrecy was not unexpected. It is characteristic, although, because it put lives at risk, including Russian lives, it is a great tragedy in this particular instance.

It is a reminder of the importance of safety. The Soviets are not as meticulous in their concern for safety as we are. I think that has been our observation in Soviet military programs as well as civilian programs.

For example, they tolerate levels of radiation in their nuclear submarines that we would not tolerate because it poses a hazard to the health of the crew.

I believe Andrei Sakharov has commented in the past on the concern he felt early in the history of the Soviet nuclear program at the lack of concern for safety.

This, in part, is why I said earlier, although it may seem ironic, that I would hate to see a cessation of nuclear testing, for that would mean the Soviets would content themselves with the current inventory of weapons at whatever level of safety they have managed to achieve with their technology thus far.

I think the advantages of ending nuclear testing are small in relation to the risks. That is why we have taken the view that the goal is a long-term goal and not an immediate one.

Mr. BARKER. Senator may I add that I agree with you. I think Chernobyl does have a message.

I think those of us who have been involved with the arms control process with the Soviet Union, and speaking personally, are worrying more about the verification and compliance aspects of arms control and see the continuation of a typical pattern, one of not being forthcoming, one of not being willing to address the facts in a timely manner.

I think it was not a surprise to us what happened with the Soviet's lack of information about Chernobyl because it was so typical. But we may be more aware of how typical it is than many people have a chance to see.

Senator PRESSLER. Mr. Chairman, let me conclude by stating that my position on the ratification of the Threshold Test Ban and Peaceful Nuclear Explosive Treaties has shifted because of these two incidents—the Chernobyl incident and the Corrtex, their refusal to participate in an examination of the Corrtex technology. It seems to contradict what Viktor Karpov has said a number of times for the record.

I do believe that it is very reasonable for stronger verification procedures and techniques to be part of the treaties. I think that those procedures and techniques have improved substantially in the past few years.

I hope that we continue to press them publicly on this issue of Corrtex, and invite them to examine it again and get a response.

Senator EVANS. The record will remain open for the remainder of the day for questions from both members here and all of the members of the committee.

Thank you.

Senator Cranston.

Senator CRANSTON. Thank you, Mr. Chairman.

In the interest of time, I will have no questions. I will briefly summarize my statement which I ask appear in the record.

Senator EVANS. Your full statement will appear in the record.

Senator CRANSTON. I welcome these hearings on the vitally important issue of nuclear testing. I have long believed that we are unlikely to make any real progress on United States-Soviet nuclear weapons reductions until we each halt nuclear testing.

A simultaneous nuclear test ban is the most significant and straightforward way of achieving this goal.

A mutual testing halt offers us a chance to cut through all the rhetoric and propaganda spewed out by both the Kremlin and the White House, and to take a concrete step to halt arms escalation.

I have recently introduced legislation that would cut off funding for nuclear warhead tests provided the Soviets join us in a moratorium. This bill has been cosponsored by several of my colleagues, including other members of this committee.

A similar measure introduced in the House has 93 cosponsors.

An end to nuclear testing would also preserve the current U.S. lead in weapons development and warhead development.

The short record of past moratoriums is a good one. The U.S.S.R. has given encouraging signs in recent months that it is willing to move ahead to bring about an end to all nuclear testing and that it is willing to negotiate onsite inspection to aid in verification.

There are other developments on the testing issue which also concern me.

In February, the Los Angeles Times printed a story which alleged the U.S. nuclear warheads were never designed for stockpile longevity. This policy, the decision to favor complexity over long-term reliability, contradicts the stated U.S. policy of over 30 years to strive for a comprehensive test ban.

We must reassess this new policy in the interest of nuclear arms control and stability. And, if the administration believes that nuclear testing is essential to further development of the strategic defense initiative, then we should hear that stated explicitly.

The American public should not be led to believe that SDI is a nonnuclear peace shield when, in fact, it is preventing an agreement on ending all nuclear explosions.

This administration is the first administration of the nuclear era, either Democratic or Republican, which has indicated no serious interest in pursuing a moratorium or a treaty on nuclear testing.

I am deeply concerned that American policy on nuclear testing has been fundamentally changed without any congressional review or public debate on the issue. Arguments given for continued nuclear testing have been very flimsy. The time to negotiate a nuclear test ban is now. There can be no matter more central to the U.S. national interest than an end to the arms race.

The place to start is with a mutual halt to nuclear testing.

Thank you very much, Mr. Chairman.

[The full text of Senator Cranston's opening statement follows:]

STATEMENT OF SENATOR CRANSTON

Mr. Chairman, I welcome these hearings on the vitally important issue of nuclear testing. I have long believed that we are unlikely to make real progress on U.S.-Soviet nuclear weapons reductions until we each halt nuclear testing. A simultaneous nuclear test ban is the most significant and straightforward way of achieving this goal.

A mutual testing halt offers us a chance to cut through all the rhetoric and propaganda spewed out by both the Kremlin and the White House and to take a concrete step to halt arms escalation. I have recently introduced legislation that would cut off funding for nuclear warhead tests provided the Soviets join us in our moratorium. This bill has been cosponsored by several of my colleagues, including other members of this committee. A similar measure introduced in the House has 95 co-sponsors.

In the larger scope of the U.S.-Soviet relations, a mutual agreement to halt nuclear testing would be a confidence-building measure. It would give arms control negotiators a stable point of origin to discuss meaningful reductions in nuclear warheads and capabilities.

An end to nuclear testing would also preserve the current U.S. lead in warhead development. The United States has conducted over 200 more tests than the Soviet Union and it is widely acknowledged that our warheads are more accurate, efficient, and reliable than Soviet warheads. By allowing continued testing, we run the risk that the Soviet Union will match or surpass our current technological lead.

The short record of past moratoriums is a good one. The last time a unilateral moratorium was proposed by either superpower was John Kennedy's ban on atmospheric testing which resulted in the signing of the Limited Test Ban Treaty just two months later. And we can protect ourselves against a potential Soviet breakout by keeping test preparations up to date. My bill would allow funding for preparations for testing so that we could resume testing immediately if the Soviets violated the moratorium.

The USSR has given encouraging signs in recent months that it is willing to move ahead to bring about an end to all nuclear testing. They have won an important public relations victory by abiding by a nine-month unilateral moratorium. In the meantime, the United States has conducted at least nine nuclear tests. The Soviets have also indicated a new willingness to negotiate on-site inspection to aid in verification. In any case, verification issues are a proper matter of negotiation, and not an excuse not to negotiate. Quite frankly, it sometimes sounds as though American arms control negotiators are concerned that the Soviets will give them an offer that's too good to refuse.

The nuclear testing issue is more than just another item on the U.S.-Soviet agenda. The explosion at the Chernobyl nuclear plant once again showed that the uncontrolled forces of nuclear energy respect no national boundaries. Recognizing this, the leaders of six key nations have asked President Reagan and General Secretary Gorbachev to refrain from nuclear testing, and have offered to help verify this mutual moratorium. Their assistance could include on-site inspection and monitoring activities in the U.S. and the USSR, as well as in their own countries. This would significantly improve our confidence that any moratorium was not being violated.

There are other developments on the testing issue which also concern me. In February, the Los Angeles Times printed a story which alleged that U.S. nuclear warheads were never designed for stockpile longevity. This policy—the decision to favor complexity over long-term reliability—contradicts the stated U.S. policy of over 30 years to strive for a comprehensive test ban. We must reassess this new policy in the interests of nuclear arms control and stability.

And if the Administration believes that nuclear testing is essential to further development of the Strategic Defense Initiative, then we should hear that stated explicitly. The American public should not be led to believe that SDI is a non-nuclear "Peace" when it in fact is preventing an agreement on ending all nuclear explosions.

This Administration has consistently opposed any negotiations with the Soviets on a comprehensive test ban, despite the fact the United States has committed itself to those negotiations in the Non-Proliferation Treaty and in numerous public statements. This Administration is the first Administration of the nuclear era either Democratic or Republican which has indicated no serious interest in pursuing a moratorium or a treaty on nuclear testing.

I am deeply concerned that American policy on nuclear testing has been fundamentally changed without any congressional review or public debate on the issue. Arguments given for continued nuclear testing have been flimsy. The time to negotiate a nuclear test ban is now. There can be no matter more central to U.S. national security interests than an end to the arms race. And the place to start is with a mutual halt to nuclear testing.

Senator EVANS. Thank you very much, Senator Cranston.

With that, this has been a fascinating panel. I think the extent of the questions indicates that there is considerable interest. I know that we will have further hearings on this issue with other witnesses, and we may well need, at some time in the future, to ask one or all of you back for further clarification, or perhaps "verification" of statements we will hear in the future.

Thank you all very much.

Mr. PERLE. Thank you.

Ambassador HOLMES. Thank you, Senator.

Mr. BARKER. Thank you, Mr. Chairman.

Senator EVANS. Next, I would like to call to the witness table Adm. William Crowe, Chairman of the Joint Chiefs of Staff.

Admiral, we welcome you to the committee. You may proceed as you like.

Your full statement will be included in the record.

STATEMENT OF ADM. WILLIAM J. CROWE, JR., USN, CHAIRMAN, JOINT CHIEFS OF STAFF, THE PENTAGON

Admiral CROWE. Thank you, Mr. Chairman.

I do plan this morning merely to summarize my statement, if that is all right with you, Mr. Chairman.

Senator EVANS. Certainly.

Admiral CROWE. I do appreciate this opportunity to contribute to your deliberations on various proposals to ban the testing of nuclear weapons. My statement, which we have just mentioned, does address the issue of testing broadly and, I believe, comprehensively, with emphasis on linkages between testing and deterrence, the prime mission of our nuclear forces.

To begin, I share the view of many on this committee that the world would be better off without nuclear weapons. But, until that occurs, some of us more or less have to mind the store, making sure that we have a nuclear deterrent as reliable and as credible as we can make it, with minimum risk to our national security.

As Secretary Weinberger stated in his fiscal year 1987 report to the Congress, we seek to prevent war by persuading potential adversaries that the cost of attacking us will exceed any gain that they could hope to achieve. This is the core of our defense strategy today, as it has been for most of the postwar period.

I am not sure that the Soviet military establishment looks at deterrence in exactly the same context.

I know that we and they approach the strategic balance in different ways. For their part, the Soviet Union takes a very robust and multifaceted approach toward this balance. It has over the course of time acquired an unusually large number and a wide mix of offensive nuclear forces:

An air defense system, with extraordinary radar coverage and interceptor density around the nation's periphery;

The world's only operational ABM system, featuring interceptor missiles with both conventional and nuclear warheads;

An antisatellite system operational for more than two decades, including missiles with a conventional warhead designed to blast satellites out of the sky;

A shield of earth, rock, concrete and steel around many of their nuclear forces, coupled with a concurrent program hardening command, control, and communications facilities and equipment; and

A heavy emphasis on damage limitation through civil defenses.

Thus, while the Soviet Union has pursued a comprehensive nuclear testing program over time, that program—and I want to stress this—is only one component of a military strategy forged around a massive array of offensive and defensive forces.

For our part, we have never tried to emulate the Soviet fortress mentality; nor do we replace our strategic offensive forces at the same pace as one sees in the Soviet Union.

Instead, we historically have let our deterrent rely heavily on the incremental modernization of existing launch platforms, with recurring emphasis on nuclear weapon technologies. To illustrate this point:

Over the years, we could have emphasized large ICBM's and megatonnages in warheads. Instead, we leaned toward more accurate missiles and new warheads of lower yields.

We might have moved more quickly toward an entirely new design for our ballistic missile submarines, featuring larger tubes or more missiles per submarine, or a larger inventory of SSBN's. Instead, we applied the multiple independently targetable reentry vehicle solution, the MIRV solution, in other words.

Similarly, in the mid-1970's, a decision not to replace the aging B-52's was accompanied by the development of an entirely new weapon system centered around cruise missiles.

For better or worse, many of these decisions were made on the basis of fiscal constraints. Sometimes they were accompanied by an illusion that nuclear disarmament was just around the corner. In any event, improvements to our systems placed proportionately greater emphasis on weapons, rather than the proliferation of basic platforms. This, in turn, has led us to rely, and to rely heavily, on a comprehensive nuclear testing program.

Today, of course, we are forced to replace aging platforms with a new Trident submarine, the B-1 bomber, and the Peacekeeper.

We fully expect that these new platforms will be around for a long time, barring some major initiative, a successful initiative, in arms control. They will be, in that event, the mainstay of our nuclear deterrent force. In turn, we must retain the flexibility to make incremental improvements in weapon systems designs and validation of such designs through the Nuclear Testing Program in order to insure that these systems remain an effective and credible deterrent.

At this point, let me say just a few words about Soviet policy on nuclear testing.

In general, the Soviet Union has been reaching for the high ground in political and social propaganda, condemning in particular the United States program. In reality, however, I would argue that their nuclear disarmament proposals of mid-January do not contemplate a worldwide ban on nuclear testing until the late 1990's—more than a decade from now.

In the interim, these proposals suggest only that the United States and Soviet Union join in a moratorium or delay in nuclear testing—an arrangement which can be broken and which, in fact,

worked very much to our disadvantage in 1961, when the Soviets broke out of a 3-year moratorium with the most intensive Nuclear Test Program in history. Even their recent suspension of nuclear testing seems to have been a temporary political expedient. They are now gearing up for resumption of such tests.

As a whole, the Soviet nuclear disarmament proposals of mid-January serve their security interests, not ours. We should, of course, not expect otherwise. But, even if we are able to find a more equitable road to nuclear disarmament, that road will have its own asymmetries, uncertainties, and potential instabilities in the East-West military balance.

As the process evolves, both sides can be expected to place a premium on the survivability, reliability, and effectiveness of that last component of their nuclear capability. In this regard, General Secretary Gorbachev was correct when he noted, "the interrelationship between offensive and defensive arms is so obvious as to require no proof." What he did not mention are some very obvious efforts by the Soviet Union to strengthen such linkages within their own force structure, including, but certainly not limited to, an Earth and space shield for many of their nuclear strike forces, national command structure, and communications assets. For deterrent purposes, it is absolutely essential that we be able to place such protected targets at risk. To do this, we must be able to perfect our own nuclear weapons, as necessary, and that, in turn, requires continuity within the Nuclear Testing Program.

We also face major uncertainties surrounding the mix of launch vehicles apt to evolve from a nuclear disarmament process. We don't know whether the Soviets will emphasize mobile or hardened ICBM's, more dispersed and sheltered bombers, or ballistic missile submarines, some of which may be berthed in coastal tunnels. In any event, uncertainties surrounding the evolving mix and location of Soviet offensive forces underscore the importance of remaining flexible in weapon system design and validation of such designs through testing.

Last, the whole process of eliminating nuclear weapons on a worldwide basis is fraught with extraordinary problems of compliance and verification. We do not know, in the first instance, whether nuclear disarmament is an achievable proposition by the year 2000. Further, we have no way of knowing whether a nuclear disarmament treaty, even one pursued diligently by the United States and the Soviet Union, will capture the last weapon on Earth. Thus, we will have to maintain a deterrent to nuclear attack right down to the last moment, and, from a United States and allied security perspective, we want that deterrent to be as effective and credible as possible. Nuclear testing, I would suggest, or argue, is required to guarantee this.

To put all of this into perspective:

A comprehensive ban on nuclear testing, now or later, will contribute absolutely nothing to nuclear disarmament. By itself, it will not eliminate a single nuclear weapon.

Conversely, continuation of a comprehensive Nuclear Testing Program can assure that we go down the road of nuclear disarmament with minimum degradation in the safety, security, survivability, reliability, and flexibility of our nuclear deterrent, and, in

turn, minimum risk to our national security as well as the security of our allies.

Thus far, I have focused upon the strategic and military requirements for nuclear testing. Let me now turn to the technical side.

In general, the design, development, and storage of nuclear weapons demand the highest standards in safety and security. We can never afford to rest on our oars. Similarly, we must ensure that all of the complex mechanisms of achieving safety and security do not, in some unexpected fashion, degrade the reliability of that weapon as part of our strategic nuclear deterrent. We can completely satisfy ourselves on that score only by maintaining in some fashion a Nuclear Testing Program.

Given a strong emphasis on product safety and reliability in the United States, I, frankly, do not understand why Congress would want to suspend testing on one of the most critical and sophisticated elements of our nuclear deterrent, namely, the warhead.

With respect to weapons reliability and effectiveness, we are dependent upon the testing program in five distinct ways.

It gives us confidence in our existing stockpile of nuclear weapons. Our fervent hope is that we will never have to use such weapons. But, like other systems not used over many years, we must be sure that they will perform as designed, and that any potential adversary be aware of this fact. That's the heart of deterrence.

It provides information essential to the effective employment of nuclear weapons—confidence that the right weapon is applied to the right target. The lethality of nuclear weapons, theirs and ours, against hardened targets is one of our major concerns. So, too, is the expected survival and performance of such weapons in a nuclear environment, featuring the synergistic effects of blast, high intensity radiation, and electromagnetic pulse.

It enables us to determine critical nuclear effects on such nonnuclear systems as surveillance, command, control, and communications systems. It is imperative that we continue to explore the nature of the entire spectrum of nuclear effects problems and develop fixes to deal with them as long as we have to rely on equipment that must function in a nuclear environment.

It helps us to verify that a weapon modified for reliability, security, or safety reasons, or a weapon tailor-made for a new delivery system, such as cruise missiles, the Peacekeeper, or the Trident D-5, will emerge as a reliable and effective component of our nuclear deterrent forces. At one time, for example, we had to recall all of the Polaris warheads because of reliability problems which degraded the inventory effectiveness by as much as 75 percent. Only nuclear testing allowed us to verify that Polaris modifications had solved the problem.

It helps us design new weapons of smaller size and weight for a given yield. For years, the United States has led the world in this aspect of nuclear technology with considerable savings in the size and cost of delivery systems. But each new delivery system and its associated weapon requires thorough testing before it can be counted as part of our strategic or tactical nuclear deterrent.

At the same time, I would emphasize that, while I do not want to go into the details, it is not uncommon for these tests to produce technical surprises—something not predicted in either simulations

or computer-based analyses. These surprises can impact any one or all of these areas: Reliability; weapons stockpile or deployment; physics studies of new concepts; or safety considerations.

Last, but not least, let me say a few words about verification and compliance.

It is clearly our biggest problem in arms control negotiations with the Soviets, whether we are talking about launchers, weapons, or testing. We would like, of course, for them to be more open, more amenable to objective verification methods. They remain very closed, and, as the Chernobyl accident demonstrated, very loath to share unvarnished data with technical experts from the United States or even from Europe.

These verification problems are compounded by a Soviet Government which sees itself in a continuing military struggle for world power and influence. On the one hand, they have shown a rather clear pattern of exploiting loopholes in any arms control arrangement, and even breaking out of existing agreements in order to continue this struggle. On the other hand, they want us to leave compliance issues surrounding nuclear testing to good faith.

I, frankly, doubt that the Kremlin will ever be able to square this circle. Thus, we must assure that verification and compliance mechanisms surrounding any nuclear testing arrangement be as direct, straightforward and objective as possible.

To sum it up, I believe that the United States way of managing its nuclear deterrent and the strategic balance is far less burdensome on our society and our economy than the Soviet way. But you must recognize that our approach to nuclear deterrence puts a premium on high technology rather than brute force. So, too, does our effort to develop a strategic defense, unaccompanied by a government and a people digging in for survival.

In defense planning, we are drawn toward nuclear testing by one simple fact: We expect to achieve deterrence from a relatively small mix of strategic nuclear forces likely to be in service for a long period of time. To maintain that effectiveness and credibility over time, we must have a weapons modernization and maintenance program supported by rigorous underground testing—the only environment left to us. We cannot assume, even in view of the Soviet proposals, that nuclear disarmament is just around the corner.

For something as exotic and potentially lethal as a nuclear weapon, such testing also is embedded in the highest standards of safety, security, and survivability, as well as reliability. We should regard with the utmost concern any suggestion that we could allow our nuclear weapons stockpile to “gracefully” degrade over time.

Further, virtually everything about the nuclear disarmament process—asymmetries, uncertainties, and potential instabilities in the evolving military balance—suggests that a comprehensive ban on nuclear testing should only occur toward the end, rather than at the beginning, of this process. Certainly this is the case for the United States and its allies, if not for the Soviet Union.

As a bottom line, I sincerely believe we stand a better chance of achieving near-term progress in nuclear disarmament with less damage to our national security by approaching weapons reductions directly, rather than obliquely through a comprehensive test

ban. The United States has formally proposed such reductions in both theater systems and strategic systems. The Joint Chiefs of Staff fully support these proposals and would enthusiastically welcome a constructive response by the Soviets to them. It has not been forthcoming as yet.

That concludes my summary, Mr. Chairman. I would be happy to address any questions.

[The prepared statement of Admiral Crowe appears in the appendix.]

Senator EVANS. Thank you very much, Admiral.

We will confine the first round of questioning to 8 minutes each.

There have been repetitive assertions this morning that testing is necessary for reliability and for assuring the effectiveness of our weapons systems. There have also been at least accusations—I don't know to what degree they are true—that in tests on some nonnuclear weapon systems—speaking now in particular of the Bradley fighting vehicle—that tests were conducted under the most benign of circumstances and really did not effectively get at the reliability of that weapon under the adverse circumstances they might face in a wartime situation.

Are we being consistent in our attitudes toward testing of nonnuclear and nuclear weapons?

Admiral CROWE. I believe we are, Mr. Chairman. But I am aware of the controversy that you mentioned, of course, with regard to the Bradley fighting vehicle.

We do a variety of tests on practically every conventional weapon system, ranging from benign to the most stressful. We get a lot of advice on our testing programs from many quarters.

Senator EVANS. I know you do, too.

Admiral CROWE. Some of it is good; some of it I am not so sure is so good.

But I just cannot tell you how many times we have reevaluated, redesigned, and reoriented our testing program not only to avoid criticism but to give us a better product.

So I don't believe that there is real substance, at least not across the board, in the charge. There may be in some individual case. When we find it, we try very hard to correct it.

But what I do find rather interesting and sort of curious is the criticism that we put things in production without adequate testing. We are criticized for it heavily. On the other hand, there are people making very strong suggestions that we not test the most sophisticated and the most lethal of all our systems, which is the nuclear warhead.

I find a certain amount of inconsistency in this.

Senator EVANS. It is my understanding that in 1977, the Joint Chiefs of Staff did support the ratification of the Threshold Test Ban and Peaceful Nuclear Explosions Treaties.

If that is correct, is that still the position of the Joint Chiefs?

Admiral CROWE. We had several disclaimers on that in our advice, sir. We supported the treaty as long as it had adequate safeguards and also as long as it was verifiable. I think that, in the end, has been the major stumbling block in this administration, as well—the verification of it.

This is still our position today, sir, that before we would support that treaty, we must have some evidence that it will be verifiable and adequately verifiable.

Senator EVANS. In the last paragraph of your written statement, you said that you believe we have a better chance of achieving near-term progress in nuclear disarmament by approaching weapons reductions directly rather than obliquely through a comprehensive test ban, and that we have formally proposed such reductions.

Does that not have essentially the same difficulty that a test ban or even a limited test ban has in terms of verification?

If we are talking about reduction of weapons, are we really moving in that direction without assuring verification of those reductions?

Admiral CROWE. Well, it depends, of course, on the specific weapon system. There are some weapon systems that certainly lend themselves to verification, even by national technical means, better than others. We can, of course, monitor and count holes in the ground. We can see submarines that are severed in two, tubes destroyed, altered, and modified so that they could not be used as a weapon system.

There are certain things that we can do.

But there are some weapon systems where the challenge is much more intense and it is much more difficult.

But I think the negotiations would include that, of course, and the place to start is in the systems that are the easiest to verify, where verification can be done without more intrusive measures.

Senator EVANS. One of the reasons advanced for the need to continue to test has been the hardening or the modernization of our command, control, communications, and intelligence systems. Would you describe for us the potential effect of a test ban on those systems, or on the reliability and survivability of those systems?

Admiral CROWE. Of course, the fastest moving part of a military technology—and it has been for a few years and will be now, I think, into the foreseeable future, is in the command, control, and communications area, in electronics and satellite communications, et cetera, et cetera. As we modernize, as we develop, or as we extend all of these systems, we have found that some of them are very, very vulnerable to nuclear effects, including blast and electromagnetic pulse effects. While we can do certain things with simulations, for example, we can do certain things by simulating electrical currents to electronically harden a product or radio or a transmitter, we cannot simulate the entire effect of a nuclear explosion or the gamut of nuclear effects from a weapon.

One of the most important aspects of nuclear testing is testing the effects of a nuclear detonation not only on weapon systems and warheads, but also on the entire spectrum of command, communications and control equipment and gear.

As long as we are going to have to fight in a nuclear environment, it is imperative that we construct that equipment and test it so that it can continue to operate, despite those effects. We have found no way at all to duplicate that completely in any other fashion, except by actually testing it in an explosive environment.

Senator EVANS. Senator Pell.

Senator PELL. Thank you very much, Mr. Chairman.

Admiral Crowe, what would be the risks of ratifying the Threshold Test Ban Treaty now?

Admiral CROWE. With no changes?

Senator PELL. No changes, as it is now.

Admiral CROWE. Well, I think they would be grave, Senator, and certainly from a military security standpoint.

Senator PELL. Could you spell that out a bit?

Admiral CROWE. Yes, I can.

To begin with, as long as the basic theme—and I believe I speak for the Joint Chiefs of Staff on this—as long as we have to rely on nuclear weapons for our deterrence, and as long as deterrence is a pillar, a cornerstone of our security policy, it is essential that we have weapons which are credible and reliable and in which we can believe and trust.

The Threshold Treaty has been honored by the United States for quite some time now. We do not see a military requirement, at least not in the immediate future, that we cannot satisfy with that threshold. But we do see, and the President has made it clear that we are seeing violations, what we believe, what we sincerely believe, are violations on the Soviet side, and it is very possible that they are getting advantages in asymmetries from this that we don't fully understand. Without verification, we simply do not want to take that risk. We believe the risk would be considerably enhanced.

I do not understand or appreciate the reluctance to investigate better measures, more secure measures, and more precise measures of verification on the part of the Soviets—if they are sincere. But I am not so sure they are sincere.

But some of the questions that the Joint Chiefs of Staff have would be dispelled if we could have an accurate and a precise and trustworthy way of determining what they are doing in the Soviet Union themselves in regard to abiding by the TTBT.

We abide by it. They know that. The world knows it. But the world does not know if they abide by it. In fact, I don't think the world believes that they do.

Senator PELL. Has the 150-kiloton limit on testing presented any problems for us, for our military?

Admiral CROWE. As I said a moment ago, as far as the foreseeable future is concerned in our military requirements, we are satisfied with that limitation.

Senator PELL. Well, then, by the same token, would there be any advantage to break that limitation, to exceed it, either by us or by the Soviets?

Admiral CROWE. Oh; yes. very much so. If you wanted to build a higher yield warhead, if you wanted to build higher yield warheads versus weight, improved warheads in a completely different range, which, incidentally, historically has been what the Soviets are the most interested in. We are the ones who have led the world in bringing down megatonnage and more precise weapons that allow us to cut down on numbers, allow us to cut down costs, allow us to cut down size. There is a whole area which not only do they incline toward but which would give them a tremendous advantage if they could exploit it.

Senator PELL. On page 7 of your testimony, Admiral, you say that a CTB would not eliminate a single nuclear weapon. Do you

really believe that a CTB would do nothing to halt the spread of nuclear weapons, their proliferation?

Admiral CROWE. Yes, sir, I do, Senator. I think a very respectable case can be made that it might not halt the spread of nuclear weapons.

You are talking about a CTB now, as I heard?

Senator PELL. Exactly. I have moved on.

Admiral CROWE. I think a Comprehensive Test Ban Treaty, with time, would introduce considerable uncertainty into the reliability of your weapons in practically every parameter, and that it can be reasoned that the way to compensate for that is to build more weapons, et cetera, et cetera, to put more weapons on a missile.

Incidentally, the Soviets deal in much more throw-weight than we do. They have the launchers, the weapon systems that would allow them to do this sort of thing, if they chose to do it to compensate for the uncertainties they had in actual warhead performance.

Yes, I don't think that is too farfetched at all.

Senator PELL. What steps would you recommend to prevent nuclear proliferation?

Admiral CROWE. First of all, I would confirm or reaffirm exactly what the current administration is doing in attempting to pursue with some realism arms reductions, and that we are for that. Of course we are. The military is, too.

We would much prefer a world without nuclear weapons.

I certainly concur with the President when he says it would be a disaster of unparalleled dimensions for us to wage a nuclear war.

So, don't think what separates the two proponents on this argument is their appreciation of the horrors of nuclear war. I think we all appreciate that.

What we are looking at is the best way to get it. I think the best way to get it is to be patient, to persevere, and to put your case forward, that we want to reduce, but that we want to reduce in an equitable manner and in a verifiable manner, and broad and deep, and we want to go right to the heart of the problem, and that is the willingness of the two superpowers to reduce their weapons.

I do not see the advantage of playing around the edges, and I do not think that a Comprehensive Test Ban Treaty would lead to that. I think it would introduce elements of uncertainty that would be dangerous for all concerned.

Senator PELL. Going back to the phrase you used, "the horrors of nuclear war," we are all aware of that.

Do you think that in such a case there could be a winner on either side, or that one side or the other could prevail?

Admiral CROWE. No, sir, I do not.

Senator PELL. Neither side could prevail?

Admiral CROWE. I should stress again, though, Senator, that I am not so sure the Soviets look at it the way I do.

I think they do have a completely different view of nuclear war.

Senator PELL. Your view is that they believe they might prevail in the event of a nuclear war?

Admiral CROWE. I would never pretend to know everything about the Soviets, but at least from what I do know about them, we have strong indications that there are elements of their military that be-

lieve strongly that they could wage such a war, survive such a war, and win such a war.

I do not agree with that, Senator.

Senator PELL. Good. I am very glad that you don't agree with that. By the same token, we could not win a nuclear war either.

Admiral CROWE. I would never pretend otherwise.

Senator PELL. Thank you.

Thank you very much, Mr. Chairman.

Senator EVANS. Thank you.

Senator Mathias.

Senator MATHIAS. Thank you, Mr. Chairman.

Admiral, it is always a pleasure to have you with us.

Admiral CROWE. Thank you, Senator.

Senator MATHIAS. You were preceded in the committee by Mr. Holmes. He quoted President Kennedy by saying that we know enough never to offer again an uninspected moratorium. I would assume that the operative word in that quotation is "uninspected."

What do we need by way of verification? Would we require a physical presence, or black boxes? What, in your judgment, would provide an adequate level of verification?

Admiral CROWE. That's a very perceptive question, Senator. It has perplexed at least the military now for many years. I assume what we have been looking for—and we have done considerable looking for it—is some way that would satisfy the precision that we need in reducing the uncertainties without unacceptable intrusiveness. To be frank about it, I think it has eluded both sides in this equation. It's not that we can't develop the systems for determining what is going on, but it usually means intrusion, and usually deep intrusions.

I just don't know of any way. What the Soviets call "national technical means," which means you don't come into their country, you don't go to the sites, you don't get very close, but yet you seem to know what all is going on—we thought at one point in the development of these systems that seismological technology had developed to the point where we actually could stay great distances away and determine what was going on. I think we have discovered that, while we might be better at detecting explosions, we might be better at measuring them, we still had grave uncertainties that we could not overcome, and that, depending on what environment the weapon was exploded in, it introduced elements that we just could not solve in seismological detection.

So, what the President, with his latest offer for improving verification of the TTBT, known as Corrtex, I think, has attempted to do is to introduce into the dialog proposal of a new system in which we have great confidence that, if allowed to use it, will measure accurately these matters, give us the kind of precision that we need, and do it equitably so that both sides can take advantage of it.

Senator MATHIAS. We would accept them as well as demand them?

Admiral CROWE. Yes.

The problem as I see it in verification is that you have to have some kind of verification that not only we accept but that, in the end, the Soviets accept—accept as being right or wrong.

Right now, when you have these large elements of uncertainty, the Soviets say that is fine. But it gives them a strong foundation for arguing about any conclusion or any figure you come up with. They can dispute it, because they say your measurements are uncertain.

We don't want either side to dispute it. We don't want to dispute it. We don't want the Soviets to dispute it.

I think it is true that in their country the Soviets do not have the political climate we do. But in this country, because we do have pluralism and we do have people who are allowed to take both sides of an argument and feel it genuinely and sincerely, they, likewise, demand a certain amount of positive proof. They are not pleased with or satisfied with uncertainty.

That is the climate that our President operates in. So, he, as well as the military, is looking for ways to address and deal with this problem with precision and confidence.

Senator MATHIAS. So that I understand you exactly, there have been some indications that the Soviet Union will accept a presence of some kind—black boxes—and under the Threshold Test Ban Treaty, I think that is specifically provided for?

Admiral CROWE. Yes, we were close, we thought, at one time to that. But those were seismological devices, in countries other than the Soviet Union.

Senator MATHIAS. But what you are raising is a question that even if you have the black boxes, the evaluation of the evidence you get from the black boxes is subject to some editorial adjustment?

Admiral CROWE. That is certainly true of some black boxes.

We have been looking for techniques that do not have that problem.

Senator BIDEN. Would the Senator yield on that?

Is that correct, Admiral?

I was told by Livermore that there was no problem, that you can drop the so-called black boxes down the hole; that there is a way in which you do not have to be present, but still know precisely.

That is what I get told at Livermore.

Admiral CROWE. If you have that opportunity to put your box into the hole and then retrieve the data.

Senator BIDEN. That is what the Senator was talking about, or so I thought.

Senator MATHIAS. That was the system I think which was agreed for the Threshold Test Ban Treaty.

Senator BIDEN. Right, and it is precise. It is not as implied. It is precise—to the number.

Admiral CROWE. If it is in the right location.

Now I understood that the locations were to be determined and not to be moot. You said drop it down in the hole.

Senator BIDEN. I thought that was the Senator's question. Perhaps I was wrong.

Senator MATHIAS. I am probing what the areas are, what the possibilities are.

Admiral CROWE. I think the President's latest suggestion is certainly one that is satisfactory on this side of the fence to everybody, if it could be acceptable to the Soviets.

Senator MATHIAS. It would be acceptable to the Joint Chiefs?

Admiral CROWE. It certainly would.

Senator MATHIAS. Do you have any indication of how the Soviet Union has reacted to this specific suggestion?

Admiral CROWE. No, sir, I have none.

Senator MATHIAS. I ask because they have reacted in a positive way to other onsite inspection suggestions.

Admiral CROWE. That's true. In this one, though, so far as I know, we have had no official reaction.

Senator MATHIAS. Of course, in matters of defense, it is traditional and it is prudent to rely on your own resources.

I wonder what weight you would give to the proposal of the non-aligned nations to act as monitors.

Admiral CROWE. I think I had better qualify this as a very personal view, Senator. My personal view is that we would certainly be willing to look at that with great interest.

Senator MATHIAS. Recently, Mr. Gaffney was quoted in the New York Times, as saying, and I don't want to paraphrase him too loosely, but, as I read his statement, I thought he was quoted as saying that he thought that proliferation would be increased by a test ban. I wondered if the Joint Chiefs shared that view.

Admiral CROWE. First of all, I am not so sure that the Joint Chiefs have taken a position one way or another on that particular question.

My own view would probably be a little more qualified in that I don't know whether it would inspire or provoke proliferation. But I similarly do not accept the proposition that it would automatically not proliferate.

Senator MATHIAS. As we look toward the end period of the Non-Proliferation Treaty, it seems to me that there are political forces at work here which are troublesome and relate very directly to the question of the test ban.

As I look at them from a political point of view, it is very difficult to sustain an extension of the Non-Proliferation Treaty in the absence of some progress on the part of the superpowers, to move toward control and limitation.

Thank you, Mr. Chairman.

Senator EVANS. Thank you.

Senator Kerry.

Senator KERRY. Admiral, in 1977, the Joint Chiefs supported ratification of the Threshold Test Ban and the Peaceful Nuclear Explosions Treaties.

Are we hearing today a change in the position of the Joint Chiefs?

Admiral CROWE. I don't believe so. But, of course, in all candor, Senator, the Joint Chiefs have always said that whatever judgment they made was as of that period of time, and that if circumstances changed—and I am referring primarily to the Soviet approach to nuclear weapons and systems and hardening and passive defense measures—that they did not foreclose for all time a military requirement that would require us to do something outside of the threshold. The threshold, where it is currently placed, does have limitations as to what you can test.

Senator KERRY. I just want to make clear whether or not today you are asserting, as I think I have heard you say, that you see dangers in our embracing of the threshold test ban.

I think you have articulated that today and I just want to make that clear.

Are you today saying that the situation is changed and that you now do not recommend the Threshold Test Ban Treaty?

Admiral CROWE. The Joint Chiefs essentially support the current position, which is that if you can get adequate verification on the threshold, they do not see any military requirement that would—

Senator KERRY. Adequate verification, then, is the key. Is that correct?

Admiral CROWE. Certainly where the TTBT is concerned.

But the Chiefs—and I do not think that this is a change in course, Senator—have always been very reluctant to say that there would never be a requirement at any time to do more than that threshold. We are just not that good in controlling the future or predicting the future.

Senator KERRY. You are aware that all of the recalibrations and reestimates of Soviet tests by the CIA have revised estimates downward?

Admiral CROWE. Yes, I am aware of some public statements to that effect, sir.

Senator KERRY. So, according to that, they would not, in fact, be in violation of the TTBT?

Admiral CROWE. Well, I don't believe that that is the conclusion that has been reached.

I think that public discussion intimated that as a result of those recalculations, there were probably fewer violations, but that has not led us to conclude that there were no violations.

Senator KERRY. Also, by way of clarification, in 1977, the Joint Chiefs specifically recommended to this committee that the Threshold Treaty be ratified.

Are you so recommending to us today?

Admiral CROWE. Not without verification, no, sir, I am not.

Senator KERRY. Now, I read your testimony and I must say that there are a couple of things in it that really give me some cause for concern, Admiral.

I know you are a man who has studied a great deal of policy, and I have enormous respect for your background and am delighted that you are serving where you are. But I read here that you say that a comprehensive ban on nuclear testing now or later will "contribute absolutely nothing to nuclear disarmament. It will not eliminate a single nuclear weapon."

Let me ask you this, as a military person and making judgments as you do about systems. Would you have confidence, would you recommend to the President the deployment of a warhead that had never been tested?

Admiral CROWE. I don't think I would.

Senator KERRY. Would you have confidence in a system that had never been tested?

Admiral CROWE. No.

Senator KERRY. So, isn't it fair to assume that, if by signing the Comprehensive Test Ban Treaty we can have an influence on

Israel, or South Africa, or Pakistan, or India, or Argentina, or Brazil, and bring them into a Comprehensive Test Ban Treaty, that by virtue of their inability to test, we have eliminated a nuclear weapon?

Doesn't that contradict your own statement?

Admiral CROWE. You said that I had studied policy some, Senator. My study of policy tells me that the American example is not going to be controlling in their calculations; that their calculations are going to be controlled by their own national interest, as they see it.

Senator KERRY. I have an article here by Charles Van Doren, which appeared in the New York Times on May 5, in which he refers to his 19-year career, and he wound up as the Assistant Director of the Arms Control and Disarmament Agency.

He refers to the fact that Israel, South Africa, India, and Brazil did join the Limited Test Ban Treaty, and they expressed their determination to achieve a comprehensive test ban, and in the last 2 years, the heads of state of India and Argentina have both said in highly publicized manner that they urge a prompt conclusion of the comprehensive ban.

So, in point of fact, those nations are looking to a comprehensive test ban. I visited Geneva when the NPT Review Conference was going on, and I can tell you that a hundred and some nations were desperately looking to the United States in this area.

Admiral CROWE. Well, I see nothing to prevent those nations from not testing right now. I do not consider that nonproliferation, while it is an important interest of this country, to be our most important interest.

I consider much more, and this is really the guts and essence of the debate over CTB, that the important interest is our ability to deter on our own behalf, our own national security. There are many allies that have no nuclear weapons that depend on that deterrent.

I think a CTB is going to erode our ability to do that.

Senator KERRY. But that is a different issue—

Admiral CROWE. But that is a more important consideration in my view.

Senator KERRY [continuing]. Which I appreciate your asserting, and I can understand why you say it is more important.

But when you, as Chairman of the Joint Chiefs of Staff, as a matter of record make the declaration that the NPT will not eliminate a single nuclear weapon, then I—

Admiral CROWE. Senator, in all fairness, I was referring to CTB and to either the Soviet or the United States stockpile. But it wasn't clear, I concede.

Senator KERRY. Let me come back to that issue, then.

If you took a weapon system that has been designed for reliability for deployment for 20 years, which is what our warheads are—

Admiral CROWE. Some, yes.

Senator KERRY [continuing]. And you take that warhead and it is put together by the same process we put it together today, and it is deployed by the same process we deploy it today, would you stand 1

mile from where that bomb were dropped, if it were dropped without a new test of it?

In other words, after 20 years, if you take a new one and you rebuild it, in the same way, with the same technical specs, the same everything, would you stand 1 mile away from where it was being dropped?

Admiral CROWE. I'm afraid your question escapes me a little bit, Senator. I am not too hot about standing 1 mile away from a nuclear weapon whenever or wherever it is dropped.

Senator KERRY. Well, that is my point, Admiral.

Isn't there a deterrent? You have not tested it, but isn't there a deterrent anyway?

The point I am getting at is that it seems to me that we are not thinking clearly somehow about where deterrence really comes from.

The deterrence does not come from the individual weapon; it comes from the conglomerate——

Admiral CROWE. That's true.

Senator KERRY [continuing]. From the ability of the triad in total to pose the threat of a mutual assured destructive ability.

Admiral CROWE. But the fact that I wouldn't stand 1 mile from the explosion because I am very concerned over my own personal safety does not mean that I would still have the confidence that I would have on a tested deterrent in the macrosense.

I just plain would not, and I don't think our opponent would either.

Senator KERRY. But it seems to me that when you describe, look at and analyze the things that we are really testing for and measure that against the reliability that we get out of some of the warheads that we have had for 20 years or so, you are not really changing the fundamental reliability by virtue of the testing. What you are changing is this thing called modernization, which gives us either increased yield or greater accuracy——

Admiral CROWE. Sometimes decreased yield.

Senator KERRY [continuing]. And sometimes decreased yield, which is a tradeoff against better accuracy.

But the point that I will make and on which I will close is that all we wind up doing is this. As you sit over there and make judgments about the worst case and what they can do to us, so they do about us. And all we do is to change their threat perception about this new system, which demands in a lumbering bureaucracy like the Soviet Union a response, which takes 2 years to catch up to it. And so, we are always chasing the tail.

Verification is way behind the new system and the new system is way behind the new sense of threat perception, and we keep going in this cycle.

Admiral CROWE. It is a very difficult cycle. I would be the first to agree with that, Senator.

Senator KERRY. I think the NPT offers a chance to try to break that.

Admiral CROWE. But no matter what kind of test ban you arrive at, at whatever point you do it, the very cycle you describe means that there are going to be asymmetries. Even if everything else is even, we are progressing in different periods of time on both sides

of this equation at a time which we don't understand very well. There would be asymmetries there, even under equal conditions, clear across.

Senator KERRY. I understand that.

Thank you, Mr. Chairman.

Senator EVANS. Senator Pell has one additional question.

Senator PELL. Thank you.

Admiral, perhaps you would want to submit this for the record. Would you let us know the source, the citation of your view that there are Soviet military people, or Soviet people believe they could prevail in a military war?

Admiral CROWE. I would be happy to submit that for the record, Senator.

Senator PELL. Thank you very much, indeed.

Thank you, Mr. Chairman.

[The information referred to appears in the appendix.]

Senator EVANS. We thank you very much, Admiral, for your participation and your patience.

With that, this hearing is closed.

The record will remain open for the remainder of the day for any written questions members may wish to submit.

Admiral CROWE. Thank you, Mr. Chairman.

Senator EVANS. Thank you very much, Admiral.

[Whereupon, at 12:15 p.m., the committee adjourned subject to call of the Chair.]

NUCLEAR TESTING ISSUES

THURSDAY, JUNE 19, 1986

U.S. SENATE,
COMMITTEE ON FOREIGN RELATIONS,
Washington, DC.

The committee met at 10:05 a.m. in room SD-419 Dirksen Senate Office Building, Hon. Richard G. Lugar (chairman of the committee) presiding.

Present: Senators Lugar, Pell, Sarbanes, and Dodd.

The CHAIRMAN. This hearing of the Senate Foreign Relations Committee is called to order.

This morning the Committee on Foreign Relations continues its comprehensive examination of nuclear testing issues with the second of three scheduled hearings. Our first hearing was chaired by Senator Dan Evans on May 8. At that time, the distinguished Chairman of the Joint Chiefs of Staff, Admiral Crowe, outlined the views of the military on these subjects.

The administration's positions were presented by Assistant Secretary of Defense Richard Perle, Assistant Secretary of State H. Allen Holmes, and Deputy Assistant Director of Arms Control and Disarmament Agency Robert Barker.

A week from today we will conclude our hearings with testimony from former policy officials who have had responsibilities for America's nuclear testing policies.

Senators have expressed much interest in nuclear testing issues. Indeed, there are now five pieces of proposed legislation related to nuclear testing. They represent different views and different approaches to the various issues involved. Because so many Senators have taken a serious interest in these issues, there is a keen awareness on the committee of the complexities involved. Therefore, it was imperative that the committee hold this series of hearings to gain a comprehensive understanding of nuclear testing issues.

One reason for the complexity of today's subject is that there are actually several issues involved: First, the Threshold Test Ban and Peaceful Nuclear Explosions Treaties; second, proposals that we negotiate a comprehensive test ban; third, proposals for interim steps such as a moratorium, a lowered permitted yield for tests or a quota on tests.

Nuclear testing is also complex because it touches so directly on questions of national security. The fact is that the nuclear weapons we would all like to reduce and eventually eliminate also underpin our national security. Reasonable people may differ on the size and composition of our deterrent forces, but few would dispute that

peace now depends on the maintenance of stable and credible deterrent forces.

Therefore, any arms control program must enhance our national security. Verifiable reductions of existing nuclear weapons to equal and stable levels would certainly meet this criterion. In these hearings we must consider whether the various proposals for a nuclear test ban, moratorium, or limitations meet this criterion.

Specifically, we must determine whether further limits on nuclear testing would lead to an orderly, stable reduction of nuclear forces on both sides, or whether such limits would erode deterrence by causing uncertainty and instability.

Since the dawn of the nuclear era, people have sought to reduce and eliminate nuclear weapons. Many have suggested that bans or limits on nuclear testing could contribute to this goal. The idea was actively pursued by President Dwight D. Eisenhower whose administration explored various proposals. President John F. Kennedy was able to build upon one of these to negotiate the Limited Test Ban Treaty of 1963 which banned all tests in the atmosphere, under water, and space. The LTBT controlled nuclear weapons to make a safer world.

Many have since argued that a nuclear test ban or some interim limitation would make us more secure and set us on the road to eliminating nuclear weapons. Unfortunately, the potential contribution of such suggestions is not as clear as it was for the LTBT.

It is clear that the administration officials who testified before this committee on May 8 do not believe that a test ban, moratorium or other limitation would now enhance our security, increase our stability, or lead us to real reductions of existing nuclear weapons. They see a sequential path to nuclear disarmament, with a test ban making sense only toward the end of that path. Thus, the administration sees a test ban as a long-term goal which can be achieved only when certain preconditions have been met.

Assistant Secretary Holmes said that we would first have to achieve broad, deep, and verifiable arms reduction, better verification capability, a greater balance in conventional forces and less reliance on nuclear deterrence. Admiral Crowe pointed out that our nuclear deterrent must keep pace with the Soviet nuclear and non-nuclear programs. Dr. Robert Barker explained that we must continue to test in order to modernize our forces to meet these evolving threats, to insure the continued reliability of our deterrent forces and to test the effect of a nuclear environment on essential elements of our defense such as command, control and communications systems.

He added that nuclear testing has enabled us to reduce the size of nuclear weapons, enhance safety and provide greater security from terrorists. These are powerful arguments which we must consider carefully.

We must not argue that a given proposal would do harm or only present a small risk. Rather, we should seek proposals which maintain strategic stability and lead directly to the elimination of existing nuclear weapons. Naturally, to be workable, any such proposal would have to be effectively verifiable.

Finally, nuclear testing is also made complex because judgments about it must be based on scientific facts and procedures which few

really understand. Today we must explore how nuclear testing is necessary to modernize and maintain reliability, and whether alternate techniques are feasible.

How could we adjust to an evolving threat without testing? What would be the costs of a lower threshold or quota? Finally, we might explore some aspects of TTBT verification. To help us in this regard we have with us today a distinguished panel of scientists who have been directly involved with nuclear testing throughout their careers: Mr. Donald M. Kerr, senior vice president of EG&G, Inc.; Mr. C. Paul Robinson, group vice president and principal scientist for Ebasco Service, Inc.; and Mr. Carson Mark, a member of the Nuclear Regulatory Commission's Nuclear Safety Committee.

We are also very fortunate to have with us today Ambassador Paul Warnke who directed the Arms Control and Disarmament Agency and brings a wide range of experience in arms control issues to our hearing this morning.

Before asking our distinguished panel for their statements, I would like to ask my colleague Senator Pell for his opening statement.

Senator Pell.

Senator PELL. Thank you very much, Mr. Chairman.

First, thank you for your willingness to respond to our request that these hearings be held. I know you share my view that the test ban continues to be the major arms control issue.

At the committee's first hearing on this subject on May 8, I was very disappointed to find the administration remains adamantly opposed to ratification of the 1974 Special Test Ban Treaty and the 1976 Peaceful Nuclear Explosions Treaty, without additional verification provisions, and there is still more reason for opposition to a comprehensive test ban and even to negotiations for a CTB.

The Honorable Allen Holmes, Assistant Secretary of State, speaking for the administration, told our committee:

As we have stated often the CTB remains a long-term objective for the United States in the context of achieving broad, deep, verifiable arms reduction, substantially improve verification capabilities, expanded confidence building measures, and greater balance in conventional forces at a time when a nuclear deterrent is no longer as essential an element as currently for international security and stability.

Mr. Chairman, there are so many reasons cited not to have a test ban, the administration, I believe, might just as well have said we will oppose the CTB, at least until the Sun sets in the East.

I regret very much that our Government has descended to the point at which it sees no apparent merit in a concept that has had the support of every previous administration from President Eisenhower through President Carter. Moreover, we should be concerned of the casualness with which solemn pledges to the international community that we will seek an end to testing have been disregarded.

Our administration's enmity toward further controls in nuclear testing becomes a still more stark testimonial to what I believe is a bankrupt arms control policy when viewed in the context of the willingness to abandon SALT and to be content with negotiations which so far have yielded nothing concrete.

To my mind it is amazing that in half a decade, in 5 years, there has not been 1 inch of progress toward a truly more secure world

or a world where arms control is more extant. We cannot be content with this situation. Congress must move to regain momentum and direction. That is why, together with Senator Danforth and 20 cosponsors, we have introduced the new resolution, Senate Joint Resolution 252, renewing the call for Presidential support for ratification of the TTB and PNE Treaties and for a resumption of negotiations on a comprehensive test ban which could be achieved in one step or in balanced steps.

In addition, the Pell-Danforth resolution urges the President at the earliest possible date to, one, call upon the Soviet Union to join in the further agreement, reducing the permitted yields of explosions, as specified in the Threshold Test Ban Treaty and the Peaceful Nuclear Explosion Treaty; reduce them to the lowest possible verifiable levels which advances in seismic detection and other verification capabilities would allow; and second, to seek Soviet agreement to facilitate negotiation by declaring at the earliest practical date a mutual moratorium of finite duration on nuclear explosions.

To my mind, it is outrageous that we have allowed the Soviets to have the high road on just about all the arms control issues, including test ban initiatives. Rather than simply claiming that the Soviets are not serious, we should be putting them to the test. We should be saying put up or shut up. We should be doing our utmost to get their agreement for strong and verifiable arms control accords or show them up as fakers.

Since 1981, there has been a lot of administration chit-chat about arms control, but there have been no major agreements—not one. Apparently none is in prospect. As the administration leaves office in 1989 with no record of arms control achievement—none—it may please a few shortsighted officials but it should be a source of acute regret and embarrassment for those who understand the central value of arms control to our national security.

To my mind, Mr. Chairman, the panelists we have before us today are well-qualified to express the pros and cons with regard to the points I have raised, and I look forward to the morning's hearing.

The CHAIRMAN. Thank you very much, Senator Pell.

Mr. Mark has been kind enough to join us, despite a prior commitment to Senator Proxmire. Therefore, I will ask him to proceed first with his statement, after which he will need to depart, and then we will hear the statements of Ambassador Warnke and Mrs. Kerr and Robinson.

I would ask each of you to try to limit your statement to about 10 minutes. It is a very complex subject, so you may not be able to quite do that, but to the extent that you can, we will have more opportunity for questions and dialog.

Mr. Mark.

STATEMENT OF CARSON MARK

Mr. MARK. Thank you, Mr. Chairman.

I must tell you I am pleased to be here with you and to be able to present a small part of the views I have. It would take a couple of hours to run down the whole list, but I think you said 10 minutes was about all you could stand.

There is a lot of difference of opinion, as you are aware, on the matter of the complete test ban. I stand on one side of that issue. Other people stand even further on the other side.

One point which absolutely must be solidly in everyone's mind is that if we have a complete test ban so that no nuclear tests occur, one must reconcile oneself—which might not be hard—to the idea that there could not be any new nuclear weapons produced by us and put into the stockpile, with the reliance that is called for on putting a weapon in the stockpile.

We cannot now calculate the behavior of some assembly system with anything like the confidence that would be required to warrant putting that device in our arsenal and counting on it for filling some role.

That is perhaps not absolutely entirely true. We could make some fission bombs, interpolated between fission bombs we have seen, and feel good enough about them to say, well, this was 10, and that was 20, and this new one is 15, and we could put it in. It would have to be a very simple sort of bomb and it would have to be an interpolation between things we have already certified.

A new weapon, something which has some feature that we have not yet been using, should not be thought of as one of the things that the Nation ought to count on. We would have to live with the weapons we have, in the way they are. One should not ask the designers to swear that they know what would happen with a new one. By new, I mean new in some significant way.

That has another corollary. In the past, weapons have been designed to meet military characteristics, features spelled out and insisted upon by the Department of Defense. We would have to tell the Department of Defense that they are no longer free to develop new military characteristics unless they conform with the capability and the means of use of some weapon which already exists.

You may build a new missile or build a new ship, but you will have to put the weapons on it. Just like you design new passenger airplanes; you don't ask the people to get shorter or skinnier. You adapt the plane to carry people as they are. They would have to adapt their requests to carry weapons as they are.

Now, this is often muddled up by saying that we would need expert designers ad infinitum to decide on changes in weapons as new military characteristics might require changes. Of that, one should clear one's mind. We do not really need new designers to make changes if we don't make changes. And we should not make changes. That is one point which I felt should be made obvious as it is.

I don't think there is a great deal of debate on that, but you will hear more about that later.

There is another point I would like to address some comment to, and that is I have seen or read—I really live in New Mexico so I am not part of the scene here at all, and I do not know what goes on in the real world except as it gets reflected to those remote parts—but I have read that we have got to have a great deal more verification than anybody can imagine before we could allow ourselves to enter into a test ban treaty.

And I think that is confusing the issue. We have enough verification down to some level. That level might be as low as 1 kiloton—it

is certainly not as high as 5 kilotons—at which we can count on seeing an underground explosion if one is conducted anywhere in the Asian Continent.

That puts a different light on verification. As I think Mr. Barker told you, several weeks or a month ago, there was a great gap. I do not think there is a gap as long as we think in terms of a level at which verification is in fact essentially assured.

Going on with verification—and I am talking here of seismic detection and identification—one needs both of those aspects. A week from now, I believe you are going to hear from Lynn Sykes who is probably the world's, and certainly the country's, expert on what one can deduce from a seismographic record. And he will say things which I think are not at odds with what I am mentioning now, although I am no seismologist.

In connection with the weapons stockpile. Our weapons, at least for strategic purposes, range upward from about 40 or 50 kilotons to some number of megatons. One cannot make a test at a few kilotons which will allow us to put a new weapon in the stockpile in the tens or hundreds of kiloton region. I think one may count on that as also applying to the Russians.

If we had a test ban which was set—as would seem reasonable—at a level at which detection and identification was a probable thing and that level could be as low as, say, a few kilotons—1, 5—but I do not think it needs to be as high as 5 in order to avoid debate.

They cannot, if the Russians choose to go clandestine, test at 5 kilotons and build a megaton weapon, a new megaton weapon. Now, if they just refurbish an old weapon, it does not matter to us from the point of view of overall security.

There is a point there which I believe deserves more careful thought, and perhaps Senator Pell's proposed legislation has that in mind. I have not seen it. I am sorry, but I hope to.

Another point concerning verification comes to mind when you reflect that we have made about 800 tests, I believe, since 1945. We have today in our stockpile 23 or so different weapons, or we did have a couple of years ago. That suggests that the number of tests per new weapon in the stockpile is a large number. It is not necessarily 30, but it is certainly several.

To have a test which evades detection does not mean a new weapon. A test series could mean a new weapon. Several tests are required. And that is true for us and it is true for our opponents who have got most of the obvious weapons under their belt, and for a new one they have to work very hard and test very hard, to think they have got something adding to what they already have.

The other thing which I would like to mention and then I will promise to recede: We hear that we would lose confidence in our stockpile. The way one reads that, at least when you read it on the other side of the Mississippi, it sounds as if we would lose confidence before the end of the week if we stopped testing.

That is not really terribly true. If you look at our stockpile, our strategic plus tactical, you will find that very close to one-half of the weapons on which we are relying have been in that stockpile for 20 years or more. A very few of those get tested. None of them get tested because of worry about their viability. They get tested

because somebody wants to expose some equipment to x rays or so, and so we pull one of those out and shoot it and give them some x rays to look at.

That, of course, confirms the notion that that weapon still works like it did 15 years ago when we last saw it; 85 percent of our weapons are more than 10 years old. We are not sitting around worrying about losing confidence in them. We are sitting around being fearful that the Russians might use their weapons on us. Now, theirs will not be quite as old as ours because they started a little later, but they will have the same pattern.

So that needs to be very definitely in mind in talking of the fact that within 2 or 3 years we might lose confidence in the stockpile. Well, those 20-year-old weapons in 2 or 3 years from now will be 23 years old and they will still be just as good, just as frightening, and just as useful.

I think I could go on for a very long time, but being asked to hold things down to about 10 minutes, I would think those I have mentioned are the main points which come to my mind, although there are many others of course.

Senator PELL [presiding]. Thank you very much, Mr. Mark. Am I correct in saying you will be coming back to us this morning?

Mr. MARK. I do have to appear downstairs, and I shall certainly make every effort to come back. And if you have questions, I would be delighted to hear them, but that would be a better time.

Senator PELL. That would be wonderful. Thank you very much.

Now I guess, going from left to right, we will hear from Mr. Kerr.

Mr. KERR. Please go ahead.

Senator PELL. Ambassador Warnke.

STATEMENT OF HON. PAUL WARNKE, CLIFFORD, WARNKE, GLASS & McILWAIN

Ambassador WARNKE. Mr. Chairman, Senator Pell, I appreciate the opportunity of appearing before you today. I obviously have no scientific credentials. I am not quite sure what my credentials are at this point except as sort of an expired official.

I have, however, a basic premise that affects my attitude toward a comprehensive test ban, as it does toward other measures of arms control. That is, I accept the premise that President Reagan expressed in his State of the Union speech in January 1984. He said at that time that the only purpose of either side having nuclear weapons was to see to it that they were never used.

Therefore, I do not regard them as being warfighting weapons; I do not regard them as having any particular extended deterrence magic, particularly when you are dealing with strategic weaponry.

Now, a number of reasons have been given for opposing a nuclear test ban. They were not invented by the Reagan administration. They are really issues that have been raised in every administration with which I have been familiar. They have to do, first of all, with the question of verification; second, with the question of testing to continue confidence in the reliability for stockpile.

A third argument has been made that if we suspend testing, we will lose the trained scientists, whereas the Soviet Union will be

able to maintain conscript scientists who will not be allowed to wander into better fields of growth.

Then, finally, the argument is that having a test ban will prevent development of new and safer, perhaps smaller nuclear weapons.

I think the verification argument has been substantially answered at this point. I think it is really a question as to how far down you can go. Can you get down to zero, or should you have some sort of a threshold that is in the nature of a few kilotons?

I do not really have enough scientific information to answer that question. I have an opinion. I think a total test ban is entirely verifiable. I think that is particularly true because of the fact that in the negotiations that began in June 1977, the Soviet Union accepted both the principal of onsite inspection and the idea of American seismological equipment on Soviet territory.

As a matter of fact, when the talks broke down, the issue being debated was how many Soviet seismic stations should be in the United Kingdom, not exactly the most serious of issues. So I think the verification problem can be solved.

As far as the operational viability of the stockpile is concerned, I think two aspects should be noted. Nobody has any doubt that enriched uranium and plutonium will blow up. We have demonstrated that conclusively. So really the proof testing should relate to the nonnuclear elements, things like the triggers, et cetera.

I think also as far as the condition of the stockpile is concerned, you can rebuild the weapons without having test explosions. Plus the fact that I have felt—and I think it is embodied, Senator Pell, in the statement you made in support of Senate Joint Resolution 252—you can make an argument that the less confidence either side has in the reliability of their weapons, the less chance there is of a first strike, because anybody planning a first strike, of course, is taking on a tremendous burden.

He has to assure himself that the strike is going to work, that he will be able to prevent a retaliatory strike that would destroy the attacker. Accordingly, a loss of confidence is going to impact more heavily on the one planning a first strike than it will on someone considering his retaliatory deterrent.

You would have to worst-case analyze the situation. And that would always assume that your weapons might not work but the other guy's would. So I really believe that the question of the reliability of the stockpile at least cuts both ways.

Then as for the argument that we would not be able to retain scientists with a lively interest in nuclear testing, if in fact we stopped testing, it does not impress me much. Granted, the Soviet Union as a totalitarian society could try and maintain a dedicated cadre of scientists who try to keep up their interest in testing, even though they could not test. But I think that elapse of time would solve that. Mortality would set in and perhaps Alzheimer's before that.

So, as a consequence, I do not really think we would be disadvantaged by the loss of people who are familiar with the actual testing of nuclear weapons.

I think that the only real argument for continuing to test is the argument that we want to develop new nuclear weapons, and on

that I agree with Dr. Mark. We do not need new nuclear weapons. The argument that stopping testing would mean that we could not develop different kinds of nuclear weapons is to me the best argument for a nuclear test ban.

I think for one thing, we do not want the Soviet Union to be able to develop smaller warheads with perhaps the same destructive capability. If in fact the SALT limits are allowed to lapse, it would mean that the Soviets would be better able to utilize the large throw-weight of their heavy missiles to load them up with more and more warheads, and any development toward smaller warheads therefore would be, in my opinion, inconsistent with the national interest.

With regard to the question of safe nuclear weapons, I have never really been sure what a safe nuclear weapon is. I think the only safe one is a dud, and I suspect we are not going to test to see if we can create duds. So that argument, too, does not impress me.

I think that one of the real issues that we have to consider with respect to a test ban is the impact on nuclear proliferation. Now, recently, somewhat to my astonishment, opponents of a test ban have been arguing that if we do stop testing this will increase proliferation; that those who are dependent upon the American nuclear deterrent will lose confidence in that deterrent and that therefore they will build their own nuclear weapons.

Now, I am not quite sure who these countries are. I think it is extremely unlikely that the Federal Republic of Germany, for example, is going to get into the nuclear weapons business because the United States stops testing. And I do not think that stopping testing is going to lead people to feel that our deterrent is less effective than it was previously.

I think they will feel instead that the deterrent efficacy is assured because of the fact that the Soviet Union is similarly inhibited in testing and therefore in developing additional types of nuclear weapons.

I feel very strongly that one of the major advantages of a comprehensive test ban would be the impact in shoring up the nonproliferation regime. I think it is highly unlikely that if the United States and the Soviet Union, with something like 50,000 to 60,000 nuclear warheads between them, feel that they must continue to test to bring about new nuclear weapons, we are going to be able over a continued period of time to convince other states, other sovereign states, that somehow they are second-class citizens; that the United States can be trusted to develop more and more nuclear weapons; the Soviet Union can be trusted to do the same, but somehow they cannot be trusted.

I think our ability to exercise, to exert the moral pressure to prevent proliferation is going to become less and less. Not only in the Limited Test Ban Treaty, but also in the Nonproliferation Treaty, we pledged, as did the other nuclear weapons states, that we would take prompt steps to bring about a termination of the accumulation of more nuclear weapons. We have not lived up to that pledge, and I think at some point if we still have not, that they will call for an accounting, and I think we will be faced with a situation in which there are more nuclear weapons states and, as a result,

more and more chance that nuclear weapons may fall into the hands of subnational terrorist groups.

I think a comprehensive test ban is very much in the interest of the United States.

Thank you.

The CHAIRMAN. Thank you, very much, Ambassador Warnke.

Mr. Kerr.

**STATEMENT OF DONALD M. KERR, SENIOR VICE PRESIDENT,
EG&G, INC.**

Dr. KERR. Mr. Chairman, members of the committee, thank you for the opportunity to join you this morning to discuss this very important issue.

I would like to return to some of the technical issues that were the principal focus of this hearing and in particular try to discuss the role testing plays in the development of nuclear weapons systems, because I think testing as a word means many things to many people.

For the past 20 years, I have been involved in one or another aspect of the nuclear testing program and I think it is important to recognize that it is not product testing; it is not operational testing; in fact, it is an intimately intertwined process with the design of nuclear weapons systems.

And testing is not an end in itself, but in fact the confirmation of doing a design. It is also the opportunity to experimentally explore those things which are unknown that Mr. Mark pointed out in his earlier discussion.

The purpose of testing and development is to confirm the calculations which imperfectly represent nature and give some measure of confidence in one's understanding of the physical principles by which these weapons work. Some tests are directed toward engineering purposes, to actually fit a warhead into a new environment. Others have addressed in the past issues of safety and security and, in particular the effects of nuclear weapons.

With respect to safety, that often has been an issue, intertwined considerably with security. As Ambassador Warnke pointed out, the concern for weapons that might fall into terrorist hands and other concerns about the safety of air carried systems in particular, led to a major effort to improve technically the robustness of those weapons that are deployed abroad, by introducing things like insensitive explosives that would be immune to detonation, for example, in an airplane crash, or safeing systems that would be immune to tampering and in fact deny someone the possibility of a nuclear yield if they got their hands on such an explosive device.

Those developments in fact were made possible in an atmosphere where testing was permitted because they intruded so far into the design that they represented the significant changes that Dr. Mark referred to, the sorts of changes one could not confidently make by interpolating between known points.

Testing, of course, is done by the Department of Energy as the successor to the Atomic Energy Commission and a further point one needs to take up is how much testing is needed for a particular purpose. For very complex, new systems in the past, before the

computational capabilities that exist today were available, in fact, a new development might take as many as two dozen or more tests.

Today that is rather different with the substantial advance in the ability to computationally model the physics, the number of tests is substantially reduced, and a few tests suffice to develop certain new designs. It really depends on how stressing the new design might be.

For instance, a device that was intended to penetrate ice or enter the earth and detonate while underground would have a very complicated test series associated with it because of the intimate association of the structural capabilities of the weapon, along with the nuclear capabilities.

So there is not a simple answer to give you on how many tests would be significant if you were to assign a numerical quota.

Reliability has not been a principal argument in my view. The real issue has been that of the confidence in the reliability as assigned to the stockpile and that has varied over time as well. There have been past instances where unreliable designs have been put into the stockpile. There have been other instances as Dr. Mark correctly pointed out where weapons systems have been in the stockpile as long as they had a useful military role and then retired without change.

Over recent history with modern weapons, so-called boosted weapons, about the last three decades in particular, about one-third of the designs put into stockpile have in fact had postdeployment modifications, and those modification in three quarters of the instances were in fact made necessary by information either learned through testing or later confirmed as effective modifications through testing.

I am not trying to argue that they might not have been discovered without testing, but in fact in an atmosphere where testing was permitted, that was the way they were discovered and the way that they were repaired or changed to become effective weapons.

With respect to what one could accomplish without testing, I absolutely agree with Carson Mark. That is, no weapon with strategic significance, in my view—no new weapon designs—could be introduced to the stockpile.

Arguments might be made, extrapolations from past experience offered to justify such a step, but over time I think it would be a foolish thing to do and so I agree with this point. A total cessation of nuclear testing means a corollary decision that new strategic systems in particular are unnecessary for our national security.

There have been arguments raised that better numerical simulations coupled with laboratory or zero yield experiments might make possible the development of new systems or the maintenance of our present ones. Unfortunately, numerical simulations are only as good as the physical models that we have in mind, and those models have been demonstrated to be wanting on numerous occasions.

I do not think any responsible scientist would claim that he is able to model the physical world with 100 percent certainty. Hence, we have always had the tensions between theoretical science and experimental science, mediated today more and more by what I will call numerical experiments that lie somewhat in between, but

for real advances in understanding one can never give up the experimental tests, the way to find out what the truth is behind your assumptions.

That would be, of course, absent in a situation where there was a comprehensive test ban.

Test restraints such as threshold reductions or numerical quotas provide a different set of questions. With respect to the threshold limitations, Dr. Mark correctly pointed out to you that strategic weapons with yields above 50 kilotons could not be developed as new weapons systems under a threshold of, say, 10 kilotons or below.

There is, in a sense, a value of testing as a function of yield that is perhaps worth having in mind. At a few hundred tons, there are certain things that can be learned relative to the assembly of the fissile material in the weapon. At a few kilotons, the functioning of the so-called primary or trigger can be effectively investigated, and at a few tens of kilotons, one begins to approach for certain kinds of weapons designs, the regime where the total functioning of the weapon can be explored.

Then, finally, at the full yield, one understands both the thermonuclear and the fissile material behavior in the weapons system.

The numerical quota issue on the other hand goes back to my earlier point. The number of tests required to do something significant is a function of what you are trying to accomplish, and so if one is simply trying to accomplish a certain level of maintenance of confidence or introduce a very small number of new systems per decade, a low level numerical level of tests might be an appropriate way to accomplish that.

On the other hand, if one cannot foresee the reasons for which new weapons might be needed, such a limitation might not be appropriate.

Verification, as both Dr. Mark and Ambassador Warnke have pointed out, has been a contentious issue in the nuclear field for years. It is made more so, I think, by a lack of understanding of what verification means. Most people will agree on the fundamental point, and that is detection, the basic measurement of the physical phenomenon involved, whether it is a seismic signal or in atmospheric testing, an optical signal.

Such measurements are made with a certain accuracy, plus or minus 10 percent, plus or minus 100 percent; it depends on what you are measuring and what instrumentation you have to do it.

For verification, however, you not only must make the measurement with whatever errors may be present, you have to make it over a period of time and hence you get into a point of monitoring where the reliability of your measurement system over time becomes important, and one has to deal with the problem of the probability of seeing the occurrence of some physical event.

You still have the errors in the measurement and so the real leap is then from monitoring a set of instruments that measure something to reaching a judgment about whether the ambiguities and uncertainties that result from measurement errors or imprecision are politically or militarily significant to the United States.

That is where people tend to talk past each other in my view. They can agree right up to the point of saying we can measure, for

example, with 90 percent confidence all tests that occur in a certain region of the United States or a certain region of the Soviet Union above 50 kilotons. But when you ask a different question, if there is a high probability that some number of tests could be conducted at 100 kilotons and converting that into an assessment of military or political risk, the argument becomes much more murky and more complex.

One thing that has appeared to be generally true is that relying on only one type of measurement may not give people the confidence they need to address that very difficult question. Hence, the introduction of a second measurement based on a different physical principle, such as proposed with the Corrtex capabilities recently, might be an important step forward, since it would reduce the range of uncertainty perhaps by 60 percent or so, and thereby give people greater confidence that verification was possible.

That, however, raises the issue of intrusive versus nonintrusive monitoring, which would have to be a matter of negotiation because such measurements would have to be made at the test site when the test is conducted.

Finally, there is the relationship of testing to deterrence, and there I think it is very important to recognize that once again testing, not an end in itself, is an intimate part of developing new weapons systems, driven first of all by a perception of the threat which we wish to deter, and many systems have been developed, in fact, to deal with what is seen as the evolution of that threat.

There is the political guidance and the doctrine through which our forces are both procured and later deployed. If that doctrine in fact is to hold a significant set of targets in the Soviet Union at risk and the nature of those targets changes in time, there will be pressures to develop new weapons systems. That in turn will lead to the need for testing.

So the fundamental issue becomes: Do we need nuclear weapons as the fundamental underpinning of our deterrent posture, and does that posture have to evolve as we perceive the threat to the United States evolving? If the answer to that is yes, it does need to be responsive to the threat, then testing is an intimate part of that response.

If we do not believe that deterrence need be served by the development of new weapons systems to deal with an evolving threat, then the alternate conclusion might be reached.

Last, with respect to the nonproliferation area, from a technical point of view, I think a comprehensive test ban has little to do with other nations' abilities to gain nuclear capability. Simply put, what they need is an adequate supply of fissile material and the literature that is widely available all over the world.

The scientific understanding that a supercritical mass of uranium or plutonium will explode was confirmed dramatically in 1945. None of that understanding has changed. On the other hand, the development of sophisticated weapons or strategic weapons clearly does depend on the ability to test.

With respect to the political implications, there I have to defer to those more expert in how other countries might reach a decision to have nuclear weapons, but technically at least, I do not believe that a comprehensive test ban will be crucial to that development.

With that, Mr. Chairman, I will conclude my remarks and be prepared for your questions later.

Senator SARBANES [presiding]. Senator Lugar had to leave the room to take a phone call.

Mr. Robinson, you are yet to be heard from, and I think we will just proceed now with your statement, if you would.

[The biographical sketch of Mr. Robinson appears in the appendix.]

**STATEMENT OF C. PAUL ROBINSON, GROUP VICE PRESIDENT
AND PRINCIPAL SCIENTIST FOR EBASCO SERVICES, INC.**

Mr. ROBINSON. Mr. Chairman, thank you.

I have submitted a formal statement for the record.

Senator SARBANES. It will be included in full in the record.

Mr. ROBINSON. Thank you.

I would like to summarize a few of those thoughts. I am glad that the four panelists today have all agreed on the importance of nuclear weapons in our national security. Indeed, our weapons in threatening the Soviet Union have bought a major part of the security we enjoy today. Similarly, the greatest threat we face is the reverse side of that.

I would like to concentrate on three themes: First of all, a little bit about what the role is of nuclear testing in that national defense equation; why I think a comprehensive test ban in particular is very harmful to deterrence; and in particular, the major uncertainties that the inability to test would create.

Mr. Warnke suggested that uncertainty would be a good thing, if I understood him correctly, in making us more secure. Now, I am not a logician, but I really cannot accept the thesis that uncertainty in matters on which our Nation's survival depend could ever be a good thing.

I would remind you today that all nuclear tests are conducted underground, since the Limited Test Ban Treaty of 1963. Many mistakenly identify that treaty as an arms control treaty. It was not. It is a treaty brought forward because of concern for world health. Both we and the Soviet Union and the British found that we could test our nuclear weapons underground and get the essential information that was needed with neither world health nor national security being compromised. That is continued today. We fully contain the explosions.

In our research, since the very first nuclear weapons, we have sought to simulate the functioning and the effects of the nuclear weapon. So far that has proved futile. Underground testing has remained the indispensable element of producing and measuring the effects of a nuclear explosion.

There are many purposes in undertaking U.S. nuclear tests. First of all, the physics involved in a nuclear weapon are among the most complex areas of science. Many scientific mysteries still elude our understanding and we must rely on tests.

The theories allow us to extrapolate between points of known performance, but again and again over the years as we have tried to move off of the region where we had studied before, we have been surprised, and there have been major failures.

We have developed some of the largest computers, indeed at Los Alamos and Livermore the largest scientific computers in the world, but we are a long way from being able to model and simulate what takes place in a nuclear explosion.

In a study done several years ago, we concluded we are not yet able to define even today how large a computer it might take to achieve that position.

As Dr. Kerr said, much of the research for the past 12 years has been devoted to improving the peacetime safety and security of our weapons. In this, the nuclear weapons community anticipated the growing threat of terrorism and took many actions within our weapon design and functioning to make it, first, much more difficult that a terrorist could obtain a nuclear weapon or the nuclear material. Should they ever obtain a nuclear weapon, that they could in fact detonate it to give nuclear yield.

Some of the tests deal with the engineering aspects of our weapons. We attempt to guarantee that the manufacturing process and the materials used have faithfully translated the design into hardware. In particular, one checks by that, that we have not been compromised in the design nor intentionally sabotaged either in manufacture or while in stockpile.

One class of our nuclear weapons tests evaluates the effects produced by a nuclear weapon. Here again, there are fundamental mysteries in how the outputs of a nuclear weapon affect structures and indeed affect the earth itself. The targets change by which we guarantee deterrence.

One major problem we face today is that since the late 1960's the Soviets have changed their major command structures as well as their silos, to harden them. They have built deep underground complexes that make it very questionable as whether our deterrence equation can still hold them at risk. Recent research has focused on what might be done to change that situation and restore the balance in deterrence.

For the last decade, much of our testing has been focused on the modernization of those very old weapons which Dr. Mark mentioned. Sometimes it has been possible to use a previous design in the weapon for a new delivery vehicle. However, I would like to point out that this usually makes very little economic sense.

The cost to develop a new warhead, based on the delivery system on which it to be carried, is a very small fraction of 1 percent of the total cost of a weapons system.

Finally, we indeed use testing to look to the future. The world does change, and advances in technology are always possible. In the past, technology has been the cornerstone of U.S. defense. The United States was the first to develop an atomic bomb. It was developed 4 years later by the Soviets.

The first thermonuclear bomb was developed by the United States. The Soviets followed within 1 year. There is unfortunately no foreordained right that we will always be in front, and there is always a question of who will have the next major advance.

Preventing technological surprise and guaranteeing new strength for this Nation has been a fundamental part of why we develop new weapons as we look to the future.

Let me jump now to a few remarks on how a CTB would affect deterrence. Again, there are few definitive answers. I think we can all agree that were we to stop testing, we would be out of the realm of science and into the realm of uncertainty.

The scientific method which has given us much of the world we enjoy is very specific: Put forward a hypothesis; then test that hypothesis. Depending on the results of those tests, reevaluate your hypothesis and proceed through that formalism once again.

We have no experience in any field of endeavor as to what would happen if one tried to break that formalism and eliminate testing. We have looked upon testing as a very important thing, not only to calibrate the physics and the weapons themselves, but as a means of calibrating the people who are responsible for designing and building the nuclear weapons.

Today they are all immersed in an active R&D program. That is the basis on which I believe their judgments are sound. However, we should always worry because just as in the past, we have been surprised often. Several years ago in a major strategic weapons system, we noted that the operating regime would put us far out of the range of past weapons with respect to the temperature environment of the weapon.

A large number of calculations were done, a large number of local tests were carried out. We thought we would be in good shape, but decided that, to be sure, to go ahead and do a test under those conditions. The test was undertaken and it was a complete failure.

Only after a number of major design and manufacturing changes, followed up by a larger number of nuclear tests, were we able to field a confident weapon.

One of the terms I have used for our stability is mutual assured deterrence. We are willing to be deterred as long as we believe the Soviets are also deterred. I am convinced a test ban would undermine that stability.

We have a balance in the deterrence equation today that would change, but change in unknown ways. I have always felt that restraints on testing are in fact a backdoor approach to arms control. The world is not static. I do not think it will ever be so. We continue to try and adapt the weapons of deterrence that prevent a major nuclear war from taking place.

Proponents of the test ban speak as if testing were a moral issue; in particular, its relation to nuclear proliferation. I am one of those who have advanced the statement that I see little relation to superpower testing and its effect on Third World nations in deciding whether or not they want to have nuclear weapons.

Mr. Warnke did not ask the question why would another nation like to have nuclear weapons. I think the answer is straightforward. If they feel their sovereign national security is threatened, they would like to have such weapons, essentially independent of the superpowers.

I do believe that the uncertainty that would occur might well cause them to be more uncertain about their own security and that they could not rely on the United States for their defense. I think if you will study and look for any possible benefits and compare it

to the many risks, you will conclude that a comprehensive test ban is not in the U.S. interest.

Thanks to you.

[The prepared statement of Mr. Robinson appears in appendix.]

The Chairman [presiding]. Thank you very much, Dr. Robinson. By unanimous consent we will proceed to questions, with Senators limited to ten minutes in this first round.

Senator Pell, would you like to initiate the questioning this morning?

Senator PELL. Thank you very much, Mr. Chairman. I would like to reiterate the gratitude of many of us on the committee for your permitting this series of hearings to be held. There could not be a more important subject and we are very grateful.

But addressing Ambassador Warnke, as you know, the Administration has said—and you touched on this—it needed better verification procedures.

I am wondering if you would give us your assessment of the merits of the verification provisions of the TTBT, as written now, and the PNET, as written now.

Ambassador WARNKE. Well, I think that one of the unfortunate results of not ratifying the TTBT and the PNET is that we have not been able to bring into play the verification provisions that are set forth in those treaties, such as exchange of data, calibration, and so forth.

For example, there is a provision for onsite monitoring if there is going to be a series of PNET's that exceed the 150-kiloton level. So we have less verification than we would have if we ratified the treaties. I think, however, that the verification is entirely adequate for the present 150-kiloton limit.

I think if we are going to get down to lower limits, that more verification would be desirable, if not entirely essential. As I have pointed out, during the negotiations in 1977, the Soviet Union agreed both to onsite inspection and to the stationing of American seismological equipment on Soviet territory. And I think that this is something that should be pursued.

As I say, I cannot reach any kind of a confident conclusion as to whether you can get down to zero. I think you could. But I think it is quite clear you could get down to levels that are a fraction of the present 150 kiloton limit in the Threshold Test Ban Treaty.

Senator PELL. I was very struck when we were in Moscow and the Senator from Maryland [Mr. Sarbanes], was with us. There were about six or eight of us. We had a couple of hours with Mr. Gorbachev, and in the course of that period of time he talked quite a lot, emphasized quite a lot the importance of ceasing the testing of nuclear weapons.

The arguments he made to us at that time seemed pretty solid. One, that as he put it, there would be less confidence in the reliability of nuclear weapons without testing; and also the second point, which I believe as Dr. Kerr and Dr. Mark pointed out here, that unless you have testing, you cannot have new weapons systems.

So if you carry that argument to its ultimate conclusion, that would then mean if you could stop testing entirely, at a period of years from now—20, 30, 40 years—you would not have any nuclear

weapons because you would not rely on them. And, by the same token, there would be no new weapons.

What would be the strength or the weakness of that argument? I would like to ask each one of you the answer to that.

Ambassador WARNKE. My own feeling, Senator Pell, is that you would have very little doubt of the fact that your weapons would work. You would not be able to develop new weapons. I agree with my colleagues on that, if on nothing else. But I do think that you would have every reason to feel that the weapons would explode, and I don't think that you would have the functional equivalent of the eradication of nuclear weapons by ceasing to test.

Senator PELL. Wouldn't the reliability, the sense of reliability of those weapons deteriorate?

Ambassador WARNKE. I think marginally it would. Obviously, if the uncertainty only affected the United States, that would be undesirable. The reason I feel that we don't have to worry about some erosion of confidence in the reliability is that it would affect the Soviet Union as well.

As I said earlier, if in fact our concern is about a Soviet first strike, then the uncertainty engendered in Soviet planners by the inability to test would further diminish the already miniscule possibility of a Soviet first strike.

Senator PELL. Mr. Robinson, I think, wanted to say something.

Mr. ROBINSON. Yes. Mr. Pell, if I understood your question, what would happen if we indeed did not test and the weapons became unreliable—

Senator PELL. If nobody tested.

Dr. ROBINSON [continuing]. If nobody tested, and 40 years down the line perhaps there would be no nuclear weapons because of doubts of that unreliability, I would ask: Do you think 40 years from now we might feel we need weapons? New weapons or the same weapons, to guarantee the security of the nation?

I have a feeling that is likely to be the case and that we will want to have those weapons. I would much rather see the impetus, rather than trying to make uncertainty in the deterrence equation which this test ban surely would, to put our emphasis on real arms control measures: the Strategic Arms Limitation, a SALT III, a SALT IV, the START talks, that really buy us something with respect to security, rather than this very uncertain path.

Senator PELL. The point I was making was not that there would be no nuclear weapons in 30 or 40 years, but that our sense of their reliability would be such that we would not want to use them. There is a difference.

Dr. Kerr.

Dr. KERR. Perhaps I could respond to that point, Senator Pell. I think the issue is perhaps not as much the reliability of a specific weapon, but whether it is militarily credible in the role for which it is deployed, and whether that would change over time.

For instance, the sort of weapon presently deployed, say in a Minuteman missile at the time it was deployed was sufficient to hold at risk the set of targets for which it was designed. As those targets might change over 20 or 40 years, the military effectiveness of that system would be in question. And that is without regard to reliability of the warhead.

Hence, there would be pressures perhaps to develop a new system in order to hold that set of targets at risk as they were then perceived. That in turn would engender the need for testing and hence create a national security issue at the time, relative to the ability to test and develop that new capability.

Senator PELL. Is there any way that we could find out whether our weapons are more credible and more reliable than the Soviets', or vice versa?

Dr. KERR. I think we are living in that period of the test in the sense that both appear to have been credible as far as deterring the other side. I do not care to participate in the experiment to see how thinly we can reduce the margin of safety by allowing ourselves to either lose confidence in their credibility to deter or their effectiveness as military systems.

Senator PELL. Would either Ambassador Warnke or Mr. Robinson have any reaction to that?

Mr. ROBINSON. Mr. Pell, I think we know very little of the Soviet nuclear weapon program anymore. We used to know far more in the days when they tended to vent their shots and radioactive debris did come out. We could get some insights into where they were in the development process.

That is information we have not had for quite a long time.

Ambassador WARNKE. I think, Senator Pell, that we again have come up against a fundamental difference in the way in which I view nuclear weapons as compared with my colleagues.

I do not think nuclear weapons are any damn good. I would like to see them all gone. I don't think you can use them selectively. I think the concept of a limited and protracted nuclear war is a classic oxymoron, like Amtrak's schedule. So that I don't really feel that a loss in an ability selectively to attack particular target systems is any real loss.

If there is a strategic exchange between the United States and the Soviet Union, we will both disappear as modern civilized societies, and that is the fundamental deterrent. So the important thing is to have a survivable retaliatory deterrent. That does not require further testing or further tinkering with nuclear weapons.

Senator Pell: Personally I would agree with you, but I recognize there is some controversy on that position. But both you and President Reagan agree on the idea of removing nuclear weapons from the arsenals of the world.

From the viewpoint of military credibility, it is a mutual suicide if you do use them, and yet we continue on this path.

So I guess my question to you, Ambassador Warnke, how would you answer those who say that as long as we need a nuclear deterrent, we will need to test?

Ambassador Warnke. I think it depends upon what you think that nuclear weapons can deter. Now, experience has indicated they do not deter conventional war in Third World situations. We have not been able to make a credible threat to use nuclear weapons against nonnuclear weapon states.

I do not think that it is credible to assume that in the event of a conventional attack by the Soviet Union that we would convert that into a strategic exchange. There might be some possibility of

the use of tactical battlefield nuclear weapons. That presents a different kind of a problem.

But if the Soviet Union launches a massive conventional attack on Western Europe, we have to have a conventional deterrent. Now, obviously, the possibility of escalation does exist and therefore there is, I think, some marginal contribution to deterrence, even of conventional war.

I think the fundamental deterrent of conventional war is the fact that we have American troops in Europe, a much more effective deterrent against Soviet use of conventional military force against Western Europe. But I think the idea that somehow we would voluntarily convert a conventional war into a strategic exchange long since lost any plausibility whatsoever.

Senator PELL. Thank you very much, Mr. Chairman.

The CHAIRMAN. Thank you very much, Senator Pell.

Gentlemen, let me raise two issues of common sense that people outside the scientific realm might raise, I think, if they were here on this panel.

One is: Isn't it improbable that we can bottle up knowledge? People have tried to do this in many other areas, in addition to the nuclear field. Although it might be arguable that a halt in testing with regard to nuclear weapons is not simply an attempt to put blinders in place in one particular area; it seems to me that clearly it is.

One reason we have testing of weapons and the development of new systems is because life changes and other people, we assume, in other parts of the world are doing the same thing.

That, in turn, leads to a second concern, and that is simply that there is an assumption on the part of the American people that the Soviet Union would cheat, that given Soviet violations of past agreements, the Soviets would proceed apace with clandestine forms of testing despite the terms of any testing agreement. Over the course of time, such Soviet actions could have a disadvantageous impact on the United States.

Given, then, the degree of mistrust that abounds with respect to Soviet motives and activities, what advantages accrue to the United States by agreeing to a halt or major limitation on our ability to test?

Dr. KERR. Perhaps I could be the first, Mr. Chairman, to address a pair of difficult questions. With respect to the fundamental scientific information that underlies the functioning of a nuclear weapon, that is well-known today, not only in the United States; it is known, I think, equally well or at least sufficiently well in the Soviet Union for them to accomplish in their weapons development the things they think important, and it is known to many other countries as well whether they have chosen to develop nuclear weapons or not.

That knowledge cannot be returned to the bottle; put out of sight. It is in the physics textbooks round the world.

The thing that makes it difficult for countries to attain a nuclear capability is not the fundamental knowledge, but in fact access to the fissile materials, the decision to make the large capital investments to produce those materials, and the other ancillary things they would need to go from the simple demonstration, if you will,

that a supercritical mass of fissile material will explode, to the more sophisticated design that leads to a deliverable strategically significant weapon in sufficient numbers to constitute a major threat.

With respect to the continuing exploration and knowledge that is gained both by theory as well as experiment, the fundamental principles on which the weapons work, while well understood, are perhaps not always understood in sufficient detail that a confident numerical model can be made, an equation to predict how things will go.

In that sense, there is value to testing because it adds to your store of facts about the physical world. But I doubt that those facts would revolutionize the understanding of nuclear weapons to the point where a new generation or a new capability would emerge. They would increase the confidence in the ability to design and understand, perhaps reducing the need for as many tests as we have today.

The most important part of your question I believe is the one about surprise, and surprise can take many forms; for instance, the ability through experimentation to develop new means to harden; the ability to harness the energy of a nuclear explosion to do something else with it, and that underlies some of the defensive technologies that are being addressed today.

Thus, people cannot answer your question with confidence about what may or may not emerge from the exploration. The real question is, do we want to have the kinds of capabilities that could emerge and should we explore them for two reasons: one, that they might be useful to us in maintaining a stable relationship with the Soviet Union; or second, that they might be a great surprise to us if the Soviet Union developed them and we lacked the knowledge to understand what it meant.

So in that regard, I think the exploration, the scientific exploration, has an important national security role.

With respect to your other point about a distrust of the Soviet Union, a question about whether they would explore things outside of the agreements they make, I cannot speak to that. I have no knowledge directly of them doing that, although there are certainly times when the means of verification that we have, have sufficient ambiguity that one cannot say with 100 percent confidence that something did not happen. And so you are reduced to dealing with the probability of an occurrence.

It is the judgment of whether that probability is significant scientifically, militarily and politically that is of such great concern in the verification debate. There is not a scientific answer to that question. That is a judgment and it is a political judgment in the end.

The CHAIRMAN. Mr. Warnke, let me just add one further twist that Dr. Kerr's answer has spurred, as I asked you for a comment.

If one were to assume that we have sufficient weapons for deterrence, does the end of nuclear testing mean that we would not be able to proceed with the research, development and testing phases of the strategic defense initiative?

Isn't testing really required in order to perfect those defensive technologies to understand whether they are of value to us?

Ambassador WARNKE. Well, I have great difficulty, Mr. Chairman, answering questions about the strategic defense initiative, because I have never understood what it is. It appears to mean different things to different people within the administration.

For some of them it is some sort of a perfect astrodome defense. I think the one uniform theme has been that we are talking about a nonnuclear defense.

Now, if in fact we are talking about having some sort of space stations that can attack Soviet missiles in the boost phase, I would assume we would not be using nuclear weapons for that purpose. To do so would be extraordinarily provocative, and we would find that our attempt at defense meant our total elimination.

So I accept the proposition that we are dealing with a nonnuclear system. Now, I have great doubts about the wisdom of proceeding in any event because I think the logic that led us to persuade the Soviet Union to sign the ABM Treaty in 1972 still exists. But I do not think that this is related to the question of nuclear tests.

I recognize that there is apparently some support for something that is referred to as an x-ray laser. I think that Dr. Teller regards this as being an important part of some sort of strategic defense, and I gather that would require nuclear testing.

So again, it is a question of your priorities, whether you feel that a comprehensive test ban serves the interest of the United States, even if it does admittedly restrict your ability to develop new types of nuclear devices. I feel that it does. There are others that differ.

The CHAIRMAN. Dr. Robinson, do you have thoughts on these issues?

Mr. ROBINSON. Yes. Mr. Lugar, let me try your first question. The question of why others would want to have nuclear weapons is, I believe, the essential one. Today I think the level of technology is such that with a commitment of a national will and numbers ranging in a few hundred million dollars, one could achieve an initial nuclear capability.

So I do not think we can turn back the clock. What we should concentrate on is what does it take to make the world more secure so that other nations will not feel in doubt about their security.

The question of whether the Soviets might cheat—here we have a very fundamental question in comparing two societies. I can tell you that with respect to the past treaties, not only has the United States not cheated, but I believe our system is such that it would be impossible to cheat.

Were any of my folks at Los Alamos to have ever planned and said we really need to carry out a test that is in violation of the threshold test ban, I fully expect that it would have appeared in Jack Anderson's column the following morning. I consider that a strength somewhat of our system.

On the Soviet side that is not at all the case. A large number of programs are undertaken clandestinely. There are a number of examples of that. So I think there would always be the doubt that we cannot really know what the Soviets are up to and that is why we have tried to require much more strict levels of verification for accepting a treaty.

The CHAIRMAN. Senator Sarbanes.

Senator SARBANES. Thank you, Mr. Chairman.

The first thing I would like to do is remove from Mr. Warnke's vocabulary the example of the Amtrak schedule as a classic oxymoron.

Ambassador WARNKE. I am afraid I am addicted to it, Senator Sarbanes.

Senator SARBANES. The fact of the matter is that if you are going by the schedule, it is more reliable to go from Washington to New York on Amtrak than it is to take a plane. Your chances of getting there on schedule, as told to you by the respective carriers, is much higher now with Amtrak, given the improvements that Graham Claytor has made in that operation, than they are if you fly, with all of the problems of landing and taking off and so forth at both National and LaGuardia.

I just feel it is a tremendous disservice to Claytor and the Amtrak system to use them this way.

Ambassador WARNKE. Since Mr. Claytor is a former law partner of mine, I will take that out of my vocabulary and use another example.

Senator SARBANES. All right. I would appreciate that.

Ambassador WARNKE. Supposing I switched to legal ethics. [Laughter.]

Senator SARBANES. That reminds me of the story of the two fellows who were walking through the graveyard and saw a tombstone that said "Here lies a lawyer and an honest man." And the first turned to his companion and said, "Look at that; they buried two men in the same grave."

Actually, as a former lawyer I think it is not altogether fair to the profession.

I want to ask Mr. Robinson and Mr. Kerr, if there were no more testing, how would that impact on the activities at Los Alamos?

Mr. ROBINSON. Well, let me suggest that Los Alamos does many missions for the country. The nuclear weapons research and development activities are approximately half of the activities. Those are the activities that I think we should focus on most closely in today's discussion.

During the period we got into in the moratorium of 1961, there were major changes in the laboratory and among the staff there. There had been a number of scientific questions that could no longer be investigated, fundamental questions about our nuclear warheads that could no longer be investigated. And during that brief period, there was loss of interest and a number of key staff did leave.

I think human nature is no different today than then, and that would likely be the case. It is difficult to keep a scientist interested in something that the full answer is unavailable.

Mr. KERR. As a former laboratory director, I can be more dispassionate than I might have been a year ago in answering your question, Senator Sarbanes. But I think another important difference, not to repeat what Paul Robinson just said, is that since the time of the 1958-61 moratorium, laboratories like Los Alamos, and Livermore, and Sandia have gone from being single program entities devoted entirely to nuclear weapons research and development to multiprogram laboratories involved across-a-broad spectrum of basic research and engineering development activities.

So institutionally, the answer to the question is different than it might have been in that earlier period. While those directly concerned with nuclear weapons research and development might find it less interesting because of the inability to do the job as they feel they should, there would be other opportunities within the laboratories' scientific programs for them to be usefully employed in the country's interest.

So the real issue is what does it do to the nuclear weapons capability, should that be important to the country in the future. And as others have said, it is not a question of in a very short time having the ability to reach proper judgments disappear; it is really the erosion of interest and capability over a much longer time and one where I would hesitate to make any projection.

You could use simplistic notions like what the average tenure of a scientific staff member might be and end up with a guess of about 10 years. You might reach other judgments. But it would not be immediate, and it probably would not be perceived very clearly as it went on.

Senator SARBANES. Well, would you say that in order to maintain the morale of the people in the nuclear weapons research field, it is essential to have testing?

Mr. KERR. I think perhaps the best way I could express it is, if you have a nuclear weapons research program, you must have within it theoretical investigations, computational modeling, and relevant experiments to know whether in fact your understanding of the physics and chemistry is correct.

The nuclear testing has been part of the program in that experimental area since it began. It would change the fundamental way in which questions about the physical world are addressed. So yes; I think testing is an essential part.

Mr. ROBINSON. Let me add to that, if I may. The people at the weapons labs are some of the most dedicated scientists I think you will find in the Nation, indeed some of the brightest.

One of the things that attracts them and keeps them there is the fact that they feel their work is important, of the highest importance to the country. They take great pride in being able to carry out that function to be sure that our nuclear weapons are reliable and that they are available for the country's defense.

The doubts that we have expressed that would arise if you took away testing from that I think would make the job a very unsatisfying one: where you were called upon to carry out something of the highest importance to the Nation but you did not know if you were capable of doing it. I think it would have a profound morale effect in that sense.

Senator SARBANES. Well, we may have to learn how to address that morale problem because we live in a world now in which these conflicts cannot be allowed to dictate policy. It is the same problem the military face now. They, in effect, must be able to maintain morale by not fighting, rather than one by fighting. And I have some concern that the scientists and technology are just driving the situation out of control.

I think the response to my questions provides some basis for thinking that.

Now, Mr. Robinson, one point is not clear. You said that a test ban would undermine the stability of mutual assured deterrence. Why would it do that? Why, wouldn't the existing stockpile of nuclear weapons, continue to serve as a deterrent?

Mr. ROBINSON. Just as we found in the past—and there are many examples in history—nuclear weapons do erode. They change. They change in ways we cannot predict because we do not have a full understanding of the processes that go on.

That process can be different on the two sides. First of all, the Soviet nuclear weapons, with the limited information we have, do show major differences than our own. The Soviets have invested in delivery systems, rocket systems which have enormously higher throwweights than is on this side.

If a problem does develop, at least characteristic of the problems we have seen, usually one has to make an addition and the war-head becomes significantly heavier. Thus, it is something the Soviets could adapt to that we could not.

If I bring up the subject Mr. Lugar suggested, that the Soviets might carry out some work clandestinely—

Senator SARBANES. No. I am going to address that in a minute. You will have to proceed in responding to this question on the assumption that we can verify that neither side is violating the agreement.

I happen to think that the question of Soviet intentions or trust is irrelevant, because I do not believe we would base a decision on some good faith assumption about Soviet intentions. We are only going to agree to a test ban if it can in fact be verified.

Which, of course, leads me to the further point that a test ban would restrain further technological development of nuclear weapons, and that that is desirable because further development would be much more difficult to verify.

In other words, the technology is always moving in a direction that makes verification more difficult, and if we allow the technology to run, we will not be able to match it with verification, and then clearly there will be no agreements of any sort, including the SALT III and SALT IV you were talking about.

Mr. ROBINSON. I would detect an assumption, sir, that more nuclear weapons and the evolution of nuclear weapons are considered to be a bad thing. If you would do away with the development of destabilizing weapons, you would also do away with those that could make the situation more stable.

Indeed, that is what the record has been since the 1960's. We have lowered the number of nuclear weapons. We have lowered the yield of nuclear weapons to less than one-fourth of what it was at that time, the total yield of our Nation's stockpile.

So things have been taking a better direction. I do not think that is a direction you should want to cut off.

Senator SARBANES. What direction is that now? I am not following this.

Mr. ROBINSON. Weapons are far less mass destructive than the earlier nuclear weapons of our stockpile. The total yield of the U.S. arsenal has decreased to, today, about one-fourth of what the total explosive yield was in 1966.

Senator SARBANES. Why, under a test ban, would our deterrent lose credibility?

Mr. ROBINSON. It is based on a stability that can be depended on. We know what our weapons are capable of to hold the Soviet Union at risk, to deter them from attacking us. We can only guess at their weapons.

They, I believe, similarly want to know what their weapons are capable of, to hold us at risk. That is the stability that we have achieved. It became a condition in fact far before it became a philosophical point to be debated upon. It arose on the scene.

Now, I think we can examine it and conclude that anything that would make the functioning of our weapons questionable—and I am convinced they would become successively more and more questionable as time went on, as the technology and the weapons systems themselves eroded—that would be something to detract from the stability we now enjoy in mutual assured deterrence.

Senator SARBANES. Well, both sides would experience that, would they not?

Mr. ROBINSON. Not necessarily in the same ways—and not necessarily under the same controls because of the differences in the forms of government.

Senator SARBANES. What is the alternative? If we continue to test and continue to develop new nuclear weaponry, more difficult to verify, then we diminish the opportunity for arms agreements and move into an escalating arms race.

Mr. ROBINSON. No, sir; not at all.

Senator SARBANES. Why not?

Mr. ROBINSON. What really gives stability is limiting the total mass destruction, limiting the number of weapons. I think counting of weapons is an entirely different question than verifying testing.

I would like to see our emphasis in arms control. I believe in arms control. True arms control, to try and limit the number of weapons to maintain a stable deterrence each side against the other, I would accept. And lower the total number of weapons which are out there. I believe that is the formula we should be seeking as a nation.

Senator SARBANES. Ambassador Warnke, what do you say to all of this?

Ambassador WARNKE. Really, Senator Sarbanes, I do not think that mutual assured deterrence depends upon continued tinkering with nuclear warheads.

I think what it depends upon is the survivability of your retaliatory forces. And that is a function more of basing modes than it is of tinkering with the nuclear warheads.

I think, for example, that we have by far the more survivable forces because most of our strategic warheads are in the ballistic missile submarines. You can make a good case for a mobile single warhead ICBM like Midgetman.

Testing is not required in order to improve the survivability of the forces. We have an assured retaliatory deterrent at the present point. We can maintain that with no further testing.

Senator SARBANES. Do you think that further testing will lead to developments in nuclear weaponry that will make it more difficult

to achieve verification and therefore diminish the possibility of arms control agreement?

Ambassador WARNKE. No. I support the comprehensive test ban, Senator Sarbanes, but that is not one of the factors in my thinking. I think that verification depends more again upon the nature of the delivery system than it does on the nature of the warhead.

Senator SARBANES. I see my time is up.

The CHAIRMAN. Thank you very much.

Senator Pell, do you have questions?

Thank you, Dr. Mark, for coming back.

Senator PELL. I do, Mr. Chairman. Thank you.

Mr. Mark, do you believe that the reliability of our nuclear weapons and its stockpile could be assured under a Comprehensive Test Ban Treaty?

Mr. MARK. I think I meant to imply that when I spoke earlier. I believe it can be maintained.

It will require the exercise of a rigid and thorough surveillance program which I believe is currently being conducted. Congress will have to lend its support so that it can continue to be conducted. But that program did, in about 1976—no, earlier than that—uncover a bad case of corrosion in a warhead of a particular mod number, so that the whole group became suspect, if not really worrisome.

Today, such a thing could happen anytime. That does not take away our whole deterrent. We have this mystic triad and each leg of the triad has a capability of using at least two or three weapons. That more than a very small fraction of that would show trouble is not to be expected.

And we have several times more than we could possibly find use for, so our deterrent will not be brought in question even if we discover something wrong.

As I mentioned before, and I believe you, Senator Pell, were the only member of the group here at the time, the average age of our stockpile at the moment is 20 years. And we are not really very worried about the fragility or the geriatric nature of those weapons.

The ones we are worried about are the ones that went in last year.

Senator PELL. This is perhaps off the subject, but speaking about the reliability of weapons, conventional weapons also suffer with the passage of time.

I can remember in World War II, where in an engagement the casing and the projectile fell apart because the glue dried out. They were World War I weapons.

So it can happen in either case, I guess.

Mr. MARK. I am not saying that deterioration cannot happen. I think it cannot happen seriously without being spotted if we maintain the examination. There are several things one can do. One can put some fresh glue on, in the case you have mentioned. One can certainly replace electronic gear should the crystals you use become defective.

Senator PELL. When there are simple problems like corrosion, that can be handled, too, without testing.

Mr. MARK. It could be. It could be.

Now, it is very hard to forecast and generalize. We have been in the design and production mode ever since 1945. If anything went wrong with a weapon, as it did in one of the submarine carried weapon types, we had two or three others ready, or could get one in the next few months, test it, and run it in. We did not have to fix what was wrong.

It would have been possible to have fixed it, had that been our only option, by rebuilding those things or even saying we will put a little paint on it to keep the corroding agent from reaching the reactive metal.

Senator PELL. Would a CTB with adequate safeguard verification be able to put a halt to the Soviet development of weapons as well?

Mr. MARK. I am not sure that I caught that question, sir.

Senator PELL. Would a CTB place meaningful curbs on the growth of the Soviet strategic arsenal?

Mr. MARK. Would it——

Senator PELL. Would it put a meaningful curb——

Mr. MARK. Meaningful curb? Oh, they would not—look, they are very sensible people, those Soviets, no more or less dreamy than we. I do not think they would rely on weapons in their stockpile that they had not seen work.

Now, they have got enough to go on with and they do not want to spend more money any more than we do. It would put a curb on their developing new things because I don't think they will do it without testing, and if they test for 100 kilotons, we will see it. But they will not do that.

Senator PELL. From your own experience when you were working with the laboratories, do you believe that they should put more emphasis on the reliability of the weapons they are testing?

Mr. MARK. Well, as Mr. Robinson said, there is some evidence that their warheads may be heavier than ours. We have worked ourselves silly, trying to make ours lighter than we should have. Just for that reason ours may be more fragile, possibly.

I do not know that they are any more subject to corrosion than theirs, nor that the high explosive compositions that they use are any more stable than ours, or less. I do not think we have anything to go on to make a sensible statement that theirs are more or less fragile.

By being heavier, they could, had they made use of that, have had things be more rugged, less sensitive to some small disturbance than we think ours are.

Senator PELL. This question I would like to address to Ambassador Warnke, if I could.

To achieve a CTB, do you think that a series of steps would be the best approach in that direction or should it be done simultaneously? Should there be a moratorium of fixed length of the proposed treaty, the proposed resolution?

How would you get there? What would be your approach?

Ambassador WARNKE. I do not think there is any one formula that necessarily would have to followed, Senator Pell. Politically, it

might be more saleable to do it in a set of steps, but there might be some advantage in going cold turkey rather than trying to taper down.

I think that no matter how you get to the end result, it is the end result that matters. As far as a moratorium is concerned, there is such a thing as a negotiator's pause that sometimes facilitates negotiations. I would see no reason not to have a moratorium. It would have to be, I think, of finite length.

You would have to have some definite idea that this was not a substitute for a treaty, because otherwise you would have in effect a test ban without the various safeguards that could be built into a treaty, the various verification provisions and so forth.

So that, as I say, it seems to me the approach that is taken in the Senate Joint Resolution 252 is a reasonable approach; that we ought to explore the ways in which we could achieve the end result of a test ban. That could be done in a series of steps.

Senator PELL. Thank you very much, Mr. Chairman.

The CHAIRMAN. Thank you very much.

Senator SARBANES. I have one more question.

The CHAIRMAN. Yes, you may. Wait just a second for a short announcement.

We have a vote on the floor.

Senator Sarbanes.

Senator SARBANES. I am not clear about this. Are you opposed to the PNET and the Threshold Test Ban Treaty as well?

Mr. KERR. No. In my case, I have supported the threshold test ban and the PNET treaty. I happen to agree with Ambassador Warnke's point that ratification would have provided additional information which would have been very useful in diffusing some of the misplaced arguments over verification.

The issues that have arisen have been in fact the issues of how you deal with uncertainty and the debate over verification means could have, I think, either been advanced within a framework of a ratified treaty to permit other kinds of measurement to be made and thus reduce those uncertainties, and that would be far better than the situation we have at the present time.

Senator SARBANES. Mr. Robinson.

Dr. ROBINSON. Let me echo one part. I support the PNET much more strongly than the threshold test ban. I have no problem in ratifying the PNET if we could do it separately.

With the TTBT, we presently find we can only verify by national technical means, about a factor of two. Now, I do not think that is going to get appreciably better at all if the treaty is ratified and we get some of the seismic mapping from the Soviets which would be engendered with ratification.

If it takes ratification to go ahead and move on to techniques that are now available which could bring the errors down to a 30-percent limit, to one which has been proposed by President Reagan when he invited the Soviets to come over to this country and witness a test and explore that technology, if that is the only way we

could get to that point, then I might say, well, let's ratify it in order to get there.

I think it is important for us to get down to the 30-percent error rather than the 100-percent error we have today because military significance in terms of violations can occur at the 300-kiloton level, which they can do today and we will say nothing.

Senator SARBANES. Dr. Mark, what is your position?

Mr. MARK. On? I am not quite clear.

Senator SARBANES. The threshold test ban.

Mr. MARK. Well, I am all in favor of the threshold test ban at about 3 kilotons. If we cannot get there, then 5.

Robinson is, of course, correct that our uncertainty in reading these foreign yields is great. We make it greater than it is, especially if we don't change to the recipes that we know should apply from the old ones we have been using, which exaggerate the size of the yields seen.

I did want to make a point if you will pardon me, Mr. Lugar. I am afraid of the idea of what might come to mind if you talk of a CTB—complete test ban. I think we should give thought at least to whether the things banned or forgone should not be in the region that might be seen, because if we ban things we can't see, then our imagination is open to suppose that all kinds of things are happening just around the corner.

I remember the last time we had a situation like this, and that was 1959 or so, being called into Washington to ask what is a nuclear explosion? And they had a definition which was identical with the power output of a large power reactor. Anything bigger than that would be an explosion, wouldn't it? And I said no.

But there was a great deal of trouble, especially when it fell into the hands of lawyers who don't understand ERGS and things like that, to decide what an explosion was.

I do not think we should ban something we cannot in any way lay hands on. We can lay hands on possibly 1 kiloton or 3, or something like that. We could agree on what that number is and say OK. Anything above that is what we are going to forgo and you will forgo. But don't, please, stick the world with banning something you can't even tell whether people are observing or not, because we will soon get sermons on the fact that they are doing the same wrong thing, or they will get it that we are.

The CHAIRMAN. Ambassador Warnke.

Ambassador WARNKE. Yes. Let me assure Mr. Mark, the acronym CTB stands for comprehensive test ban, not complete test ban. And what that means, of course, is that we have already banned test explosions in the atmosphere, under water, and so forth. And the comprehensive test ban would also apply to underground tests.

He is perfectly correct that when we were negotiating seriously to try and get a comprehensive test ban, we did run into the problem of just what was a nuclear explosion? What was it that we were going to ban?

I suggested, not entirely frivolously, that maybe any explosion that took place in a reusable laboratory would be something that would not be banned. I think that you ought to set some sort of a limit. We ought to determine what is within the range of verifica-

tion and then make that the limit. That to me would be a comprehensive test ban.

The Chairman. Mr. Kerr.

Mr. KERR. Senator Lugar, if I could add just a further point to that. The question of what level of experiments should be permitted was raised by Ambassador Warnke. I think reasonable people only differed by a factor of 1,000 or 10,000 at that time.

The further point I wanted to make, however, was the need for balance. Much of the attention today has been focused on restraining testing either through the number of tests or the yield of those tests. Others have raised the issue of restraining deployment.

There is something in between those two, and that has to do with the production of weapons systems as well. My feeling is that priority attention ought to go to the weapons deployed; they are the ones that threaten us today. The second priority to those that in production, not yet threatening us, but soon to be on the scene; and the third priority is that of trying to deal with technological development and what I will call the future weapons systems.

One needs to focus on that set of priorities. To some degree, test bans have always risen in priority as negotiations slow down and people find the higher priorities intractable, they fall back on the more arcane and obscure area of nuclear testing.

The CHAIRMAN. Thank you very much, gentlemen, Senators. We appreciate your coming and your sage advice.

The hearing is adjourned.

[Whereupon, at 12 noon, the hearing was adjourned subject to call of the Chair.]

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NUCLEAR TESTING ISSUES

THURSDAY, JUNE 26, 1986

U.S. SENATE,
COMMITTEE ON FOREIGN RELATIONS,
Washington, DC.

The committee met at 10:04 a.m., in room SD-419, Dirksen Senate Office Building, Hon. Richard G. Lugar (chairman of the committee) presiding.

Present: Senators Lugar, Helms, Mathias, Tribble, Evans, Pell, Zorinsky, Dodd, and Kerry.

The CHAIRMAN. This meeting of the Senate Foreign Relations Committee is called to order.

This morning, the Committee on Foreign Relations continues its examination of nuclear testing issues. In our initial two hearings, we had the opportunity to hear from distinguished witnesses from the administration and a panel of accomplished scientists who have had practical experience in the field of nuclear testing.

This morning we will hear the testimony of two former Government officials, a well-known seismologist, and a scholar in international affairs.

We have embarked upon these extensive hearings because the nuclear testing issue is such a multifaceted and complex one.

Before we form opinions and judgments on a subject so central to our national security, we must examine in a precise manner the associated issues.

The committee has benefitted thus far from discussions concerning the design and maintenance of our nuclear deterrent forces as well as efforts to improve the safety and security of such weapons.

Careful attention to the testimony we have heard thus far has led me to appreciate that nuclear testing issues are even more complex than first appeared. We must continue to examine such issues as the details of potential verification regimes for the Threshold Test Ban Treaty, the Soviet nuclear testing program, and the potential impact of the various proposals before us on U.S. modernization programs, such as Midgetman.

Other Members of the Senate who have put forward proposals relating to nuclear testing issues have expressed interest in participating in the committee's deliberations, and we will certainly do our best to accommodate those requests.

This morning we have with us a distinguished panel of witnesses who will, no doubt, assist the committee in its deliberations on many outstanding issues associated with nuclear testing.

We have with us, as a panel, Dr. John S. Foster, vice president for science and technology of TRW, Inc., and former Director of Re-

search and Engineering at the Department of Defense; Dr. Alton Frye, Washington director and senior fellow at the Council on Foreign Relations; Dr. Lynn R. Sykes, Higgins professor of geological sciences, Lamont-Doherty Geological Observatory at Columbia University; and Dr. Richard Wagner, vice president of Kaman Sciences Corp., and formerly Assistant to the Secretary of Defense for Atomic Energy.

Before asking these gentlemen to proceed with their testimony, I would like to call now upon the distinguished ranking member of the committee, Senator Pell, for his opening comments.

Senator PELL. Thank you, Mr. Chairman. I join you in welcoming our witnesses today and thank you and congratulate you for responding to our request to have this series of hearings.

I recognize that we are going to be interrupted at 11:00 o'clock and, with the business agenda that we have, we may not have a chance to return to this subject today.

So my hope is, Mr. Chairman, that we could hear from each one of the witnesses, give each at least 5 or 8 uninterrupted minutes for their key points, and that the rest of the time that we have could be pro-rated for questions.

The CHAIRMAN. That is an excellent suggestion. I hope it is one that meets congeniality with the witnesses.

Our predicament is, gentlemen, as Senator Pell has indicated, that at 11 o'clock we are hopeful of having a business meeting to put forward some important nominees for ambassadorial positions. We would hope we would have some time for discussion after your statements, but we are in the final day on the floor with respect to a number of issues, and we may be called back and forth.

For the moment, if you would try to give testimony of 8 minutes, we will insure that the entirety of your testimony is before us.

All of the papers that you have presented will be made a part of the record, by unanimous consent.

Will you please testify in the order that I introduced you, and that would be, first of all, Mr. Foster, then Mr. Frye, Mr. Sykes, and Mr. Wagner.

Mr. Foster.

STATEMENT OF JOHN S. FOSTER, VICE PRESIDENT FOR SCIENCE AND TECHNOLOGY, TRW, INC., AND FORMER DIRECTOR OF RESEARCH AND ENGINEERING, DEPARTMENT OF DEFENSE

Mr. FOSTER. Mr. Chairman, I have provided a statement, and as you have indicated, it will be placed in the record.

To read it would take longer than the time permitted, so with your permission, I would like to just read a few selected paragraphs.

The CHAIRMAN. That would be fine.

Mr. FOSTER. My approach in trying to set a framework for the important points will be to analyze the arguments for the comprehensive test ban by examining the most important facts and realities pertaining to a test ban and its results that we can state with some confidence; then I shall try to derive some logical consequences from those facts, which then lead to some arguments against a test ban as well.

As I understand them, the four principal arguments that have been presented in favor of a test ban are:

One, the absence of testing necessarily injects in the minds of military strategists and Government decisionmakers some uncertainty as to the reliability and performance of their strategic nuclear weapon forces. However, this uncertainty is not symmetric. That is, a nation considering launching an offensive first-strike would need a much higher confidence in the reliability of its nuclear weapons.

Two, a comprehensive test ban could be a palpable next step toward global strategic arms controls and reductions. We need major, mutually beneficial steps, like a ban, to establish the confidence necessary for more difficult, more complex arms control issues.

Three, banning nuclear weapons testing stops the development of new kinds of higher technology nuclear weapons. Therefore, stopping testing represents a straightforward way to halt the development of high technology nuclear weaponry, which is a principal driver for the strategic arms race.

Four, continued nuclear testing promotes nuclear proliferation. Weapons testings by the superpowers acts as an incentive to the development of nuclear weapons in third nations, since those nations perceive there is no genuine interest in curtailing nuclear weapons by the superpowers.

With these arguments as the background, let me now offer a series of facts about nuclear weapons and nuclear weapons testing.

The first and obvious fact is that a comprehensive test ban eliminates no nuclear weapons of itself and does not necessarily lead in any logical way to the reduction of stockpiles.

The second fact is that nuclear weapons decay as a function of time on the shelf. The rate at which they decay and the extent of deterioration of their performance at various times are strong functions of the particular design and construction of the weapons themselves.

The third fact is that the United States capability to design, construct, repair, or repackage nuclear weapons declines very strongly if testing ceases.

The fourth fact is that it is clear that the United States currently has no readiness to test programs to support the resumption of atmospheric nuclear testing should the Soviets resume such testing.

But the Senate ratification of the atmospheric test ban was specifically predicated upon the maintenance of a strong readiness to test program in our national laboratories and the Defense Nuclear Agency. That safeguard provision, for readiness to resume testing in the atmosphere, has failed us.

The fifth fact is that even in the face of a comprehensive test ban, rigorously observed by both sides, the fabrication of new nuclear weapons can and will likely be continued. The absence of testing merely restricts the development of new types of nuclear weapons and warheads. It does not prevent either side from continuing to construct more warheads of types that side has already designed and tested.

Now, what conclusions can we reasonably draw from this set of facts? These conclusions will lead to some arguments against a test ban.

First, I think it is obvious that confidence in the reliability of our nuclear stockpile will decline as time passes. The same thing will be true to some extent of the Soviet confidence. If our confidence in our stockpile declines and we have a way of evaluating how much it has declined, it is very likely that the Soviets will gain accurate knowledge of that perception; that is to say, they will know what we will know about the unreliability of our stockpile.

The converse is not likely to be the case.

In fact, it is entirely likely that in our system and possibly that of the Soviets, the word on actual decline in stockpile reliability may never get to the top. Expecting the highest levels of officials to gain the complete details of unreliability in these systems is, as the shuttle disaster has illustrated, an optimistic view of things.

This tends to weaken the argument that Soviet first strike will be strongly discouraged by perceptions of low reliability.

On the other hand, the Soviet leadership acts very seriously about their nuclear weapons systems. If they believe there is a reliability problem, I think we can be confident they will do something about it. They have several options.

First, they may just go for more weapons of possibly several different types against the affected target set. In other words, they might just build more.

However, they might also choose to fix the problem. They might fix it by simply abrogating the agreement and proceeding to test.

However, they may also choose to violate the agreement, covertly if the reliability problem can be addressed by underground tests of a few kilotons.

On the other hand, if they should find a need to test at high yield, they have adequate capabilities for deep space experiments in regions where we have no capabilities for determining that they have tested.

On the whole, it seems illogical to plan unreliability into strategic force operations as a means of reducing tensions.

Look at it this way: If we wish to introduce unreliability into the force, why don't we merely stop worrying about the state of our command and control systems; or, why don't we enter into an agreement with the Russians that would debilitate both of our command and control systems?

Clearly, such a course would be irrational. Yet, it is logically equivalent to the function proposed here for a comprehensive test ban.

It also seems illogical to propose that we will gain some benefits from reducing our confidence in our nuclear stockpiles, and then follow that proposal with further proposals to reduce the numbers of weapons.

This is essentially equivalent to placing our total operational credibility in our deterrent in doubt voluntarily. If the other side does not have such doubts for any reason, we will have created an extremely unstable situation. In fact, it has been a strong principle of arms control thus far that reduction in total numbers of deter-

rent force weapons should be accompanied by increased confidence in the survivability and reliability of those weapons.

That is why we want to increase the security of command and control. That is why we worry about bomber and ICBM survivability.

So, in summary, it seems to me that the argument in favor of the comprehensive test ban that arises from a perceived value of uncertainty is fallacious. Such uncertainties are not fundamentally desirable and, to the extent that they are asymmetrical, they tend to work to the benefit of the Soviet Union.

Similarly, the argument for a comprehensive test ban as a next step in arms control seems to fail in the same way. If we start by introducing uncertainties and lack of confidence in our deterrent forces, we will have introduced a disincentive, rather than an incentive, for a reduction in numbers of strategic weapons.

The incentive works the wrong way.

Now, with respect to the argument concerning stopping technology, since it is still possible to build new strategic delivery systems, the United States will be forced by the test ban to choose between not modernizing its strategic forces or building new weapon systems that are more expensive than they need to be.

This seems to make the arms race worse, not better.

With respect to the proliferation argument, we must expect that the third nations whom we wish to influence will notice that, although testing has stopped, both of the superpowers continue to develop new weapon systems employing new nuclear warheads. It would be naive to assume that they are so naive as to mistake the difference, and presume that we are not continuing to modernize and develop our nuclear forces.

Thus, such an action would be only cosmetic in terms of proliferation resistance.

The third nations will decide whether or not to develop nuclear weapons by deciding what is in their own best interests, just as they always have.

So, finally, I find that if we examine the arguments in favor of a comprehensive test ban in terms of their logical justification and their symmetric application, they are found to be wanting on both counts. The logical justifications for such a ban seem not merely weak, but inherently fallacious.

It also seems clear to me that in several critical aspects, the effects of such a ban will not be symmetric between the United States and the U.S.S.R. and will generally act in their favor.

For the foreseeable future, our strategic security will depend upon our possession of a deterrent whose basis is nuclear weapons. That means that we will maintain the stockpile of these nuclear weapons and will maintain and upgrade the weapon systems that employ them.

I cannot see how we can think it in our best interest to reduce our strategic weapons to a few thousand, or even a few hundred, in our possession and prepared for use, while at the same time putting ourselves voluntarily in a position in which we no longer have anywhere in the country people who really understand how those weapons work, how they are made, and what they will do.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Foster appears in the appendix.
The CHAIRMAN. Thank you very much, Mr. Foster.

Mr. Wagner.

Mr. WAGNER. Senator, I thought Mr. Frye was going to go next.

The CHAIRMAN. Yes, pardon me.

Mr. Frye.

Mr. FRYE. Either way, Mr. Chairman.

STATEMENT OF ALTON FRYE, WASHINGTON DIRECTOR AND SENIOR FELLOW, COUNCIL ON FOREIGN RELATIONS

Mr. FRYE. Thank you, Mr. Chairman. I am delighted to be here.
Thank you Senator Pell and Senator Evans for being here also.

I think what the committee is doing is very important at this stage in the debate on nuclear testing. This is an issue that has concerned the Senate and the American people for more than a quarter century, and we need some fresh thought and fresh action concerning it.

I think we ought to be clear on a few points.

There are risks with continued nuclear testing, and there are risks without continued nuclear testing. The choice of which risks to bear is perhaps the gravest responsibility of elected officials.

Equally important I would suggest is the task of shaping a policy which can overcome the longstanding division among Americans on this question.

I think the moment has come when it is possible to do so.

Twenty-three years ago, the Senate played a decisive role in confining nuclear tests to underground explosions. The Dodd-Humphrey resolution of 1963 made clear that, while our ability to verify a complete ban on tests appeared inadequate, the Senate would welcome a ban on tests in those environments which could be monitored with confidence.

That Senate initiative anticipated and invited the Limited Test Ban Treaty, concluded later that year.

Today, a similar opportunity exists, where the Senate can take the lead in moving nuclear test policy to the next stage.

In recent months, both Houses of Congress have urged ratification of the Threshold Test Ban Treaty and resumption of negotiations for a comprehensive test ban. It is evident, however, that the administration will not seek a CTB, although it says such a treaty remains a goal for the future.

The administration insists that nuclear testing must continue, so long as the United States relies on nuclear weapons for deterrence.

Unless we can frame a creative compromise, there is likely to be protracted legislative-executive discord over this issue. The United States is also likely to remain isolated internationally, as it has been for some time on this issue.

I would like to preface my recommendations by noting that the earlier disputes over verification of test restraints have receded substantially as technical capabilities have evolved.

Those who previously believed, as I did in 1963, working with Members of the Senate, that a CTB would not be prudent because of the verification problem, are obliged to reevaluate that conclusion.

But the point I want to emphasize is that the improvements in verification capabilities have had important political impact. For example, Norwegian scientists and officials have been collaborating with us to install and operate advanced seismic facilities. As their confidence in the system's power to detect Soviet testing has grown, so, too, has the strength of Norwegian arguments that a CTB would be feasible, verifiable, and worthwhile.

Similarly, the German technical community's recognition of progress on test monitoring has fed the development of firmer support in Bonn for resumption of CTB negotiations.

Chancellor Kohl has voiced those sentiments in public and, I understand, directly in a personal letter to President Reagan just recently.

At his press conference on April 11, the Chancellor said:

A nuclear test ban remains an important goal for the Federal Government of Germany. In the view of the Federal Government, verification possibilities should no longer stand as the chief obstacles to an agreement. Both sides could consider a transitional solution for a limitation of tests.

Senior British scientists are also confident that, even without cooperative measures, the testing threshold could be lowered drastically from the current level of 150 kilotons.

In short, the emerging consensus in the international scientific community is affecting the political views of other governments. Since the United States had consistently declared its support for a CTB if it could be verified, we are paying a price in credibility by sliding off that position now that our verification objections seem less compelling.

But, for now, it makes little difference that increasing numbers of national security professionals have concluded that a CTB would be verifiable and valuable.

The practical question, the one I present for the committee's consideration, is whether we can forge a political consensus on a plan that accommodates the administration's stated concerns, while advancing the process of negotiating mutual strategic restraint.

Senator Nunn and others in this body have made a thoroughly reasonable proposal. The administration should specify the verification enhancements it says are necessary in the Threshold Test Ban Treaty [TTB], and the Senate should then consider whether to incorporate them as reservations to a resolution of ratification.

But action on the TTB and PNE agreements presents a greater opportunity for the Senate to coax negotiations in a constructive direction. It could do so by endorsing three related ideas.

First, the United States should propose an annual quota on the number of tests to be conducted by each party. Five tests a year would be ample to check for problems in the stockpile presently deployed.

Dr. Herbert York, former Director of Defense Research and Engineering, who preceded Dr. Foster in that role, estimates that, in fact, only about one test a year has been a proof test.

Second, we should urge a declining threshold in the scale of permissible tests. Former Secretary of Defense Harold Brown and other experts have embraced the notion that the 150-kiloton ceiling could be trimmed to 10 kilotons or less.

Dr. Hans Bethe has said that zero yield tests would be sufficient to assure the operability of known designs. But at the 10-kiloton level, a reasonable reduction in the present scale, tests would still be detectible, but major innovations would become difficult.

Third—and I consider this perhaps most important—coupled with the steps I have mentioned should be a proposal to conduct a 5-year experiment to demonstrate the utility of cooperative verification measures.

Proposals of that nature have implications far beyond the realm of nuclear testing. Nuclear test restraints offer an almost ideal subject for learning how to verify more far-reaching agreements, reductions accords, and the like.

On the basis of this experiment, not only with black boxes but with onsite inspection, the superpowers would be in a much better position to determine whether and how soon to establish a comprehensive test ban. In principle, they could reach that goal by further reductions of either the threshold or the quota.

Most importantly in the comments I wish to submit to you, a program of this nature would define the common ground on which an overwhelming majority of Americans can rally. We are never going to find common ground with the Soviets until we find common ground for Americans.

It would not satisfy those who demand an immediate halt to all nuclear testing, or those who insist that there be no restraints on testing at all. But it would respond to the principal requirements stated by the administration: The objections to a CTB do not apply to a quota test ban under a reduced threshold.

For those who believe that both robust defense and negotiated restraint are essential to American security, it would offer a positive agenda that promises prompt results.

Having worked with Members of the Senate on this and other issues for 25 years, I understand the great deference Senators feel for the Office of the President and the reluctance they have to assert positions at odds with an incumbent administration's diplomatic preferences. That restraint is usually admirable and wise.

But there are times when the Senate needs to consult its institutional memory in order to judge whether an exception to such self-restraint is called for.

When one considers the crucial strategic questions of recent years, the Senate has often been more far-sighted than the executive branch. If the Senate had not slowed deployment of antiballistic missile systems in the year 1967 to 1972, not only would there have been no ABM Treaty, but the United States would today have deployed an outmoded and vulnerable ABM system, wasting billions of dollars.

If the Senate had not insisted in 1976 on a survivable basing mode for the MX missile, the United States would today have deployed 3,000 hard target killers in 300 vulnerable silos—the original Air Force program. This is exactly the kind of provocative deployment the Air Force itself came to reject as dangerously destabilizing. It was saved from that deployment by the Senate.

And if the United States had acted on the Senate's advice of 1970, expressed overwhelmingly in the 72 to 6 vote for the Brooke resolution, it would have pursued a mutual ban on the MIRV'ed

ways that become known to Soviet intelligence as well as to the U.S. military. The following sections briefly review the three particular proposed prohibitions addressed by this paper and again note the consequent difficulties.

2. FREEZE ON PRODUCTION OF NUCLEAR WEAPON MATERIALS

A prohibition against production of nuclear material for weapons would present severe problems for the U.S. For one, the U.S. needs to be able to operate production reactors to produce the tritium required to keep its weapons operable. Some freeze proponents have made note of this problem. Call to Halt the Nuclear Arms Race calls for a halt only to the "production of fissionable material (enriched uranium and plutonium) for weapon purposes." Randall Forsberg in her 1982 Scientific American article notes the need to replace tritium components in weapons and states, "This implies that the freeze should allow the operation of tritium-component assembly facilities and the running of perhaps one military nuclear reactor to produce tritium."

The U.S. also needs to maintain a reserve of weapon-grade plutonium. At the very least, this is necessary to permit the rebuilding of nuclear weapons that may require an increase in plutonium-content to correct some problem. The U.S. must operate uranium-isotope separation plants to produce weapon-grade uranium, which is required to fuel the ship-propulsion reactors of the U.S. Navy, including those of the Poseidon and Trident submarines. In addition, if development of breeder reactors is to continue in the U.S. and in the Soviet Union, both nations will need to be able to reprocess reactor spent fuel to separate plutonium. This plutonium, which would be used to manufacture fuel elements for use in breeder reactors, would not be weapon grade, but it would still be usable as the nuclear material in certain types of nuclear weapons.

Some freeze advocates have noted that it can be difficult to monitor any agreed level of production other than a zero level. However, zero levels of production of nuclear materials are out of the question, because of the requirements noted above. One cannot imagine the Soviet Union or other nations agreeing not to refuel nuclear submarines or not to reprocess reactor fuel and, hence, not to operate breeder reactors.

3. FREEZE ON PRODUCTION OF NUCLEAR WEAPONS

A prohibition against the fabrication of nuclear weapons would place unacceptable constraints on the U.S. There would then be no way to respond effectively to deterioration when it is observed in the nuclear stockpile. Again, some freeze advocates have argued that it is important that no nuclear weapon production be permitted. They note that a low level of production would be more difficult to monitor than zero production. Under the proposed freeze there would be no weapon-fabrication facility in operation and, in some proposals, even no weapon-fabrication facility capable of operation.

Such a prohibition of production goes directly against the needs of the U.S. to keep its nuclear weapon stockpile in operable condition and, hence, to maintain deterrence. Even for effective stockpile monitoring the U.S. needs fabrication-type facilities, since stockpile sampling requires carefully controlled machining to disassemble weapons and requires elaborate inspection and gauging equipment.

The U.S. needs to operate weapon-fabrication facilities to rebuild weapon systems that have deteriorated. To keep from revealing serious military deficiencies, the U.S. needs

to keep any serious deterioration secret, at least until it is corrected. For this reason and other reasons, the specific rebuilding itself needs to be kept secret, and the facilities, while in operation, cannot be subject to Soviet or other foreign inspection.

4. FREEZE ON TESTING OF NUCLEAR WEAPONS

A prohibition of tests of nuclear explosives also would seriously inhibit the U.S. in maintaining a reliable stockpile of nuclear weapons. In addition to other reasons for nuclear tests, the U.S. needs the option of nuclear tests to assess the effects of weapon deterioration that may be found. Tests can be needed to determine whether an urgent or moderate response is required and to evaluate possible responses. If the deterioration is serious, all weapons of the type involved may need to be rebuilt or to be replaced by a different type, both of which are likely to require some alterations of warhead design. To make the alterations with confidence, the weapon managers will likely need one or more nuclear tests of the altered warhead.

If the warhead requires replacement by a different type, the replacement warhead will need various certification tests in its new role. It will require at least non-nuclear operational tests in the environment of the carrier vehicle, which could mean developmental flight tests, which are also prohibited under most freeze proposals.

5. OVERALL CONCLUSION

Whatever the other difficulties of a "nuclear freeze," the proposed bans that we have discussed would present great risks to the U.S. Under such a freeze there would be no assurance that major nuclear weapon systems could be kept in

working order. As in the past, serious difficulties with a particular types of nuclear warheads could abruptly become apparent. With bans in effect on rebuilding and testing, the U.S. would have no effective means to rehabilitate the weapon systems.

Any nation faced with that situation would expend great efforts to keep the difficulties secret and would have almost irresistible incentive to violate the bans. While the U.S. would have great difficulty in maintaining the required secrecy and in violating the bans without being detected, there is strong reason to believe that the Soviets could do both. There would be a major asymmetry between the U.S. and the U.S.S.R in the risks involved in entering into such a freeze agreement. The U.S. needs to seek a more realistic, less simplistic, and less risky path to the reduction of tensions between the U.S. and the Soviet Union than the path offered by the freeze proposals.

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, DC 20301-2600

21 JAN 1986

In reply refer to:
I-85/18870

Honorable Edward J. Markey
House of Representatives
Washington, D.C. 20515

Dear Congressman Markey:

On behalf of Secretary of Defense Weinberger, I would like to thank you for your letter of 4 December 1985 requesting information regarding the military characteristics (MCs) of nuclear weapons, specifically a "requirement that weapons be designed so that they could be remanufactured in the future without explosive 'reliability' testing." Such a requirement, in your view, is in order given our long-term goal of a comprehensive test ban.

As you correctly point out, a comprehensive test ban, or CTB, that strengthens global stability and enhances security has been a long-term objective of the United States for some time. As you also indicate, for the foreseeable future, the United States will need to maintain a credible nuclear deterrent in order to ensure our national security and that of our allies and friends. In this context, the need for nuclear testing is as valid and recognized today as it was in the 1960s. Indeed, for as long as a nuclear deterrent is as essential to our security as it is today, a CTB would have quite the opposite effect to that intended. That is, a CTB in the foreseeable future would not strengthen stability but rather lead to a less secure and more dangerous world as the nuclear nations, unsure of the reliability of their nuclear weapons, increased their stockpiles to compensate for this uncertainty and as some non-nuclear nations, unsure of the reliability of the guarantees of the nuclear states, decided their security required them to build independent nuclear deterrent forces.

In 1963 President Kennedy forged a consensus for ratification of the Limited Test Ban Treaty (LTBT) around Safeguards which assured conduct of comprehensive, aggressive, and continuing underground nuclear test programs to add to our knowledge and to improve our weapons in all areas of significance to our military posture for the future. The Safeguards also required maintenance of modern nuclear laboratory facilities and programs in theoretical and exploratory nuclear technology to ensure continued progress in that technology. In part, the Safeguard concept resulted from our experience during and immediately after the 1958-61 moratorium on nuclear testing, which included serious stockpile problems with which Dr. Seaborg should be familiar. Those problems have been described in recent testimony before the HASC by representatives of the Department of Energy and the national weapons laboratories.



INTERNATIONAL
SECURITY POLICY

The consensus to maintain vigorous nuclear testing and weapons development programs and strong weapons laboratories provided the context for national decisions of the 1960s which determined the structure and characteristics of the nuclear forces we have today. Those decisions did not emphasize aspects of warhead design which would enhance weapon endurance in a no-test environment. In fact, long stockpile lifetimes were generally not envisioned in the mid-to-late 1960s because the changing Soviet threat and the rapid evolution of nuclear technology dictated constant weapon improvements.

The decisions of the 1960s, which included the choice of relatively small ballistic missiles of limited throwweight and MIRVing of those missiles with miniaturized warheads, emphasized enhanced military effectiveness, efficiency, and reliability, as well as safety, security and reduced costs in the design of our nuclear systems. Meeting these requirements has taken nuclear design in the direction of increasing technical sophistication and a stockpile ever more dependent on competent design judgments validated by continued nuclear testing. Despite improvements in calculations and in our general understanding of how nuclear explosives work, nuclear testing is still essential not only for continued development of new weapons, modification of existing designs, and confidence in the reliability of the existing stockpile, but also for confidence in the judgments made by the weapons designers in the performance of these tasks.

If we had placed, or were to place, primary emphasis on stockpile longevity, and today's security requirements were to continue, we almost certainly would need larger, heavier warheads in greater numbers and with larger yields to maintain today's level of deterrence. Hence, we would need larger delivery systems with greater throwweights. That is, we would need a costly and completely new and different nuclear deterrent force.

Today, as in the past, military requirements determine the characteristics of our nuclear weapons. In a typical case, their order of priority is: nuclear safety (always foremost), size and weight of the nuclear device to ensure compatibility with delivery vehicle requirements, minimum probability of plutonium dispersal in case of accident, operational reliability, yield, conservation of reactor products and enriched uranium, minimum maintenance, and operational simplicity.

In 1982, the DOD added warhead endurance to the military characteristics (MCs), stating the desirability of warheads with an inherent endurance obtained as a result of design considerations. These considerations address maximizing warhead lifetime, maximizing the ability to replicate the warhead at a future date, and maximizing the ability to incorporate the warhead into other delivery systems.

Therefore, the design, development, and production must be well documented and involve processes that to the extent possible allow replication at a future date. Beyond this, however, it would be futile for us to insist in the MCs on weapons whose reliability can be ensured indefinitely in the absence of nuclear tests. This is simply impossible, even if we were to relax all other requirements; without recourse to nuclear testing we would soon lose confidence in the design judgments applied to stockpile-aging and -rebuilding problems.

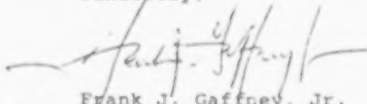
If the MCs result in design conflict, priorities are usually observed in the order listed, giving consideration to tradeoffs which allow high-priority MCs to be attained while minimizing the degradation of the competing lower-priority MCs. Technical feasibility and cost provide the basis against which desired competing characteristics are measured, with nuclear safety the overriding requirement. Lifetime is maximized to the extent possible, consistent with attaining the other MCs.

As a practical matter, we cannot always remanufacture nuclear warheads using original design specifications. First, they might not satisfy current military requirements or meet the evolving Soviet threat. When an existing well-tested design can be adapted for a new application (e.g., the Peacekeeper warhead), modifications are necessary to make the design compatible with the new weapons system and to meet other requirements. The modifications are generally extensive enough to require not only expert design judgment but also further testing. Second, older designs lack what are now considered essential features for safety and security. In addition, production requires monitoring by the weapon designer. For an older design, the original designer might no longer be in the weapons program, forcing reliance on people without first-hand experience in the weapon and competent only to the extent of their current testing experience. Materials, fabrication techniques, and equipment used for older weapons will not necessarily be available or permissible for health and safety reasons. Substitutions often affect the operation of the weapon; they require judgments regarding the need for testing to provide assurance that failure would not result, and such judgments would be increasingly prone to error as testing experience receded into the past. Moreover, as recent hard experience has shown us, not all design problems can be eliminated by extensive non-nuclear testing alone. To rely solely on non-nuclear tests, absent actual proof tests of the weapon, would entail serious risks to the safety and reliability of our nuclear deterrent forces, and would soon reduce our confidence in those forces.

The requirement to test nuclear weapons should not be surprising to anyone. Any sophisticated equipment -- airplanes, radar, tanks -- requires testing. As complex mechanisms age, they change in ways that cannot be predicted. In the real world of engineering, nothing complex can be remanufactured -- even to precise specifications -- and relied on without testing.

In sum, I believe there is historical consistency in our position that a CTB is a long-term objective to be achieved in the context of broad, deep, and verifiable arms reductions, substantially improved verification capabilities, expanded confidence-building measures, greater balance in conventional forces, and at a time when a nuclear deterrent is no longer as essential an element as currently for international security and stability. As President Kennedy wrote to Senate leaders in 1963 during the LTBT ratification hearings, "While we must all hope that at some future time a more comprehensive treaty may become possible by changes in the policies of other nations, until that time our underground testing program will continue."

Sincerely,



Frank J. Gaffney, Jr.
Deputy Assistant Secretary of Defense
Nuclear Forces & Arms Control Policy

EDWARD J. MARKEY
7TH DISTRICT, MASSACHUSETTS

COMMITTEES

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SUBCOMMITTEE ON ENERGY
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COMMISSION ON SECURITY AND
COOPERATION IN EUROPE

Congress of the United States
House of Representatives
Washington, DC 20515

December 4, 1985

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The Honorable Caspar W. Weinberger
Secretary of Defense
Room 3E880, The Pentagon
Washington, D.C. 20301-1000

Dear Mr. Weinberger:

I am writing you to clarify some questions I have regarding Defense Department preparations for the possibility that the U.S. and the Soviet Union may in the future agree to a Comprehensive Test Ban Treaty.

As you know, for over twenty years U.S. national policy has been to work for an end to all nuclear testing:

- * With the signing of the Limited Test Ban Treaty of 1963, the United States and the Soviet Union formally committed themselves to seek "the discontinuance of all test explosions of nuclear weapons for all time."
- * In 1979, both nations signed the Nuclear Non-Proliferation Treaty, which further required them to "pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control." According to the Arms Control and Disarmament Agency, "A Comprehensive Test Ban Treaty prohibiting the testing of nuclear explosives is viewed by many non-nuclear weapons states as a sine qua non for preventing the emergence of additional nuclear-weapons states and for preserving the NPT regime."
- * In 1974, both nations signed the Threshold Test Ban Treaty, which bound them to "continue their negotiations with a view towards achieving a solution to the problem of the cessation of all underground nuclear weapon tests."

Inasmuch as the eventual negotiation of a Comprehensive Test Ban, and preparation for such an agreement to go into effect has been formally incorporated into the aforementioned international agreements, I had always assumed that the Defense Department's stated requirements for nuclear weapons included a requirement that weapons be designed so that they could be remanufactured in the future without explosive "reliability" testing.

I was therefore deeply disturbed by recent testimony before the House Armed Services Committee, in which Dr. Roger E. Batzel, Director of the Lawrence Livermore National Laboratory, suggested that the possibility that there might someday be a Comprehensive Test Ban was not being taken into consideration in the design of U.S. nuclear warheads. During this hearing, Dr. Batzel declared that:

"I have the responsibility to certify that weapons that have been designed at my

Laboratory will function when and if they are ever needed. These weapons were designed under the assumption that nuclear testing would continue, so that if any problem ever arose in the stockpile, a nuclear test could be performed to help certify that the weapon would continue to work as it was designed to. Under strict guidelines from the government, our scientists designed those weapons to minimize overall weapons system costs and to maximize military effectiveness, as well as being concerned with stockpile life. The designs would have been very different if the guidelines from the government had placed primary emphasis on stockpile longevity. This in turn would have led to very different military systems - missiles or other platforms with different throw-weight, range, and accuracy." (emphasis added)

I recently contacted Glenn Seaborg, who headed the Atomic Energy Commission from 1961 and 1971, on this very point. He indicated to me that, "During my tenure as Chairman of the Atomic Energy Commission in the 1960s our national policy was to seek a verifiable Comprehensive Test Ban Treaty and the development and building of nuclear weapons were conducted with this objective in mind." According to Seaborg, "I do not recall that the proof testing of stockpiled nuclear weapons was ever an issue in this connection. It is my impression that the same situation prevailed during most of the 1970s."

I am trying to determine which of these contradictory statements accurately reflects U.S. policy and I request your advice on the following questions:

1. Does the Defense Department currently incorporate the possibility that there may someday be a Comprehensive Test Ban into the development and product specifications of new nuclear warheads and components?
2. If not, when, how, and why did this policy change?
3. Given our treaty commitments to pursue a Comprehensive Test Ban, how could weapon design specifications assume that explosive testing of the stockpile would always continue?
4. Despite the possible cost and inconvenience involved, isn't it possible to assure the reliability of the nuclear weapons stockpile through non-nuclear testing and remanufacturing of nuclear warheads using the original design specifications?

I appreciate your prompt assistance in answering these questions.

Sincerely,

Ed Markey

Edward J. Markey
Member of Congress

**NOMINATION OF DR. RONALD F.
LEHMAN II AS U.S. NEGOTIA-
TOR FOR STRATEGIC NUCLE-
AR ARMS**

Mr. PRESSLER. Mr. President, I believe President Reagan has made a very wise choice in his selection of Dr. Ronald F. Lehman II as the U.S. negotiator for strategic nuclear arms.

At the relatively young age of 40, Dr. Lehman already has compiled a highly distinguished record of public service. As a volunteer, he served in combat as an officer with the U.S. Army in Vietnam from August 1970 to August 1971, and continued to serve in the Army Reserve until February 1986.

Upon completion of his doctoral program at Claremont Graduate School in 1975, and following 1 year as a public affairs fellow at Stanford University's Hoover Institution, he came to our Nation's Capital. Here he served on the staffs of Senator McCLELLAN of Idaho, Senator Scott of Virginia, Senator Bartlett of Oklahoma and, for 4 years, with Senator Tower of Texas and other members of the Armed Services Committee. I recall with appreciation his great knowledge of defense issues and his helpfulness to me during Senate floor consideration of defense authorization bills. Since 1982, he has worked in the Department of Defense, the Department of State and on the National Security Council, primarily in the fields of arms control and United States-Soviet relations. Since last year, he has been the deputy U.S. negotiator for strategic nuclear arms.

Now Dr. Lehman is replacing former Senator John Tower at the arms reduction talks in Geneva. I commend him as a dedicated, capable and effective public servant and negotiator and wish him the very best in his efforts to preserve and enhance U.S. national security while striving for a balanced and verifiable nuclear arms reduction agreement. He has mastered the art and science of negotiation, and we look forward to the fruits of his labor in the Geneva arms reduction talks vineyard.

Admiral Crowe: My view results not only from considering Soviet statements but also from years observing the Soviet military establishment; its large number of offensive nuclear forces, coupled with an extremely complex air defense system, an operational ABM system, an anti-satellite system, an extensive program dedicated to hardening their command, control and communications facilities and equipment, as well as their nuclear forces, and a heavy emphasis on damage limitation through civil defense. The following Soviet authors and their works provide insight into Soviet thinking on the subject;

- Colonel V. Chervonobal, "Principles of Military Art and their Development," Voyennaya Mysl, November, 1977.
- General V.L. Govorov, "U.S. World Hegemony", Victory Day Speech, 9 May 1986.
- Marshal of the Soviet Union (MSU) Kulikov, "For the Sake of Peace", Victory Day Speech, 8 May 1984.
- MSU N.V. Ogarkov, "For Our Soviet Motherland; Guarding Peaceful Labor", Kommunist, October 1981.
- _____, History Teaches Vigilance, Voenizdat, 1985
- _____, "Reliable Bulwark of Socialism and Peace", Krasnaya Zvezda, 23 February 1983.
- MSU V.D. Sokolovskiy, Soviet Military Strategy, 1968.
- Colonel A.A. Sidorenko, The Offensive, 1970.

An indicative quotation that comes to mind is one from Marshal of the Soviet Union Nickolai Ogarkov in History Teaches Vigilance when he said that:

Military operations will be carried out simultaneously in vast zones, will be distinguished by unprecedented ferocity, will be highly maneuverable and dynamic and will continue until total victory over the enemy.

....Soviet military doctrine requires not merely defending ourselves, confronting the aggressor with passive means and methods of defense, but also the ability to inflict upon him crushing retaliatory strikes and to destroy him in any situation.

PREPARED STATEMENT OF C. PAUL ROBINSON

Thank you for the opportunity to speak with you. There can be few more important subjects than the long-term security of our nation and the roles which U.S. nuclear weapons play in guaranteeing that security. Similarly we should be constantly reminded of the role which Soviet weapons play in threatening our security. These important issues are by their very nature complex ones. There are few easy answers.

Although I presently am Group Vice President and Principal Scientist for Ebasco Services Incorporated, an ENSERCH Engineering and Construction Company, today I want to share with you some of the unique knowledge and perspectives gained from my many years at Los Alamos National Laboratory, where for the last five years I was responsible for the laboratory's programs in nuclear weapons research, development, testing, and stockpiled systems. I will concentrate during this discussion on three major themes: the role of nuclear tests in national defense, how a comprehensive test ban would be harmful to deterrence, and the major uncertainties that an inability to test would create.

Let me remind you that today the U.S. and the Soviet Union carry out all nuclear tests underground, ever since the Limited Test Ban Treaty of 1963. Many mistakenly identify that treaty as an "arms control agreement," but it is clearly not. The elimination of atmospheric nuclear tests was a world health and environmental issue, because of the radioactive fallout which scattered around the globe from such tests. We found that we

could move such tests underground to provide the essential data we need from nuclear explosions while isolating the debris from the biosphere. Thus, neither national security nor world health are compromised by the present activities.

We have sought other methods to simulate both the functioning and the effects of a nuclear weapon, short of carrying out an explosion, but the search has so far proved futile. Thus, today underground testing remains an indispensable element.

THE ROLE OF U.S. NUCLEAR TESTS IN NATIONAL DEFENSE

U.S. nuclear tests have a large variety of purposes - from the evaluation of proper functioning of our weapons and the effectiveness of those weapons against certain targets to the measurements as to how an adversary's nuclear weapons would affect our defense assets, including our own nuclear weapons.

The physics of nuclear weapons and explosions continues to be one of the most complex areas of science. There are many scientific mysteries which elude our understanding. At Los Alamos and Livermore the world's most powerful supercomputers are in use to help analyze the processes that make such an enormous energy release possible. Yet today we are barely scratching the surface and cannot even expect in the foreseeable future to develop the physical models or large-enough computers to closely simulate the coupled hydrodynamic and thermonuclear reactions of a modern nuclear weapon. Thus, weapon science remains largely

empirical, requiring actual experiments to provide the information which our theories are incapable of supplying. Our computer models have become very useful in allowing us to interpolate performance in ranges already verified by nuclear tests, but they often fall short, and we continue to be surprised when we extrapolate beyond regimes of previous test experience.

Some nuclear tests are carried out to develop better peacetime safety and security for our weapons. This was a major theme of the test activities during the past dozen years--improving the safeguards against accidental nuclear yields or even of plutonium dispersal in crashes or fires involving the weapons. The nuclear weapons community anticipated the growing threat of terrorism and took actions to effectively thwart terrorists, even nationally sponsored terrorists, from capturing or using a U.S. device.

Nuclear tests are also conducted to evaluate the engineering aspects of our weapons - to guarantee that the designs have been faithfully translated through the manufacturing process, and that critical parts have not been compromised or intentionally sabotaged during manufacture or while in stockpile. Besides always testing at least one "factory-built" device for each new weapon system, we occasionally will pull an older device from stockpile and, without any changes, place it downhole for detonation.

Testing becomes critically important in fixing problems identified by either our extensive stockpile sampling efforts or

from actual test failures. Recently, several critical strategic systems were identified to experience temperatures far outside our previous test history. Although theoretical analyses as well as local (non-nuclear) tests showed that performance penalties ought not to occur, an actual underground test revealed a substantial failure under those conditions. A number of design and manufacturing changes had to be made including a number of subsequent nuclear tests to restore confidence in these systems.

The more distant past is replete with examples of aging effects for weapons in stockpile, creating similarly catastrophic failures. Materials within warheads can and do deteriorate over time just as do most other manufactured assemblies, such as our automobiles. The exotic materials of nuclear weapons can give off volatile chemicals which migrate within the weapon to attack and degrade other parts. Similarly low level radiations, constantly emitted by the nuclear materials, tend to degrade internal structures. In some cases we were unaware of these problems until a failed or marred test, but further testing was always essential to verify that the problems had been fixed.

Another major purpose of underground testing is to evaluate, and hopefully understand the effects produced by the energy releases from a nuclear explosion. Most of these tests are under the purview of the Defense Nuclear Agency, although the defense community and national weapons laboratories join in those experiments. Here also there are fundamental technical mysteries - including, for example, the coupling of energy into the ground

from surface explosions, information of critical importance in guaranteeing that hardened or buried targets such as silos and command and control centers can be held at risk. Continued testing is required as the character of the targets change. Since the late 60's the Soviets have continued to upgrade the hardness of their military assets by constructing deeply buried tunnels and chambers to house military and government leadership, command and control systems, launch control facilities, and fourth generation missile silos. We require additional data on ground coupling for the new warheads being evaluated for possible use against these much harder targets.

Additional information is also required for more esoteric nuclear weapons effects such as blast suppression techniques, tailored output weapons (electromagnetic pulse, directed energy releases, etc.), and the recently suggested delayed collateral effects such as the postulated "nuclear winter."

The effects of the new nuclear weapons - enhanced radiation outputs and directed energy beams - must also be evaluated as to how they might be used against U.S. warheads or other targets. The vulnerability of our military systems to possible Soviet attacks has been growing larger over the last decade, and we have been intensifying our efforts to decrease those risks - primarily relying on the underground effects tests to quantify the physics and evaluate possible fixes.

Much of our recent testing activities has been devoted to strategic and theatre force modernization and the development of

new designs for advanced delivery vehicles. Although it has sometimes been possible to use previous designs in new carriers, this often makes little economic sense since the development of a tailored nuclear warhead design, one giving maximum effectiveness for lower weights and unique stresses, costs less than a fraction of one percent of the total acquisition price for a new weapon system.

Testing also is a crucial part in the development process of generically new weapons or new missions for the future. Advances in technology have always been the cornerstone for keeping U.S. defenses strong and unchallenged. Yet this technical advantage could disappear at anytime if we fail to undertake broad scientific investigations into those emerging technologies that could allow its possessor to prevail in any actual or threatened conflict. The U.S. developed the first atomic bomb four years ahead of the Soviet regime, but was only one year ahead in the development of the first thermonuclear device. There is unfortunately no foreordained right that we shall always be in front in the next major advance. Preventing technological surprise by an adversary while producing new strengths for ourselves is the foundation of U.S. advanced research efforts.

HOW A COMPREHENSIVE TEST BAN WOULD AFFECT THE U.S. DETERRENT

In analyzing this question, there can be few definitive answers since this issue by its very nature takes us out of the realm of science, where one can predictably relate acts to

consequences, and into a realm of uncertainty. The scientific method, which is the generator of much of the modern world in which we live, is very specific: develop a hypothesis; test that hypothesis; depending on the results of that test, modify the hypothesis; and then proceed back through the whole cycle again. Through this process one arrives at scientific certainty, a reliability in knowledge which sets it above any other field of human inquiry. If you choose to abandon the element of experimental testing, such as a comprehensive test ban would impose on our most important weapons sciences, you must be prepared to live with uncertainty.

A comprehensive test ban would produce a progressive, but uncertain, erosion of the existing nuclear stockpile. One of the heaviest responsibilities at the weapons laboratories is the certification of the designs and devices for stockpile. Certification of a nuclear weapon means that we guarantee that it will perform to specification throughout its stockpile life not only if used in wartime, but more importantly that it will fulfill its peacetime specifications as well. The certification process is a complex one involving theory, calculations, and a wide variety of experiments and tests. It requires laying out all of the design hypotheses and the experimental proof of their correctness, with a thorough evaluation that nothing of major importance has been overlooked.

Obviously certification, in the same sense as past nuclear devices, would be impossible under a comprehensive test ban. But

history has shown us that past certifications could also be plagued by doubts as well. Effects due to the inevitable deterioration over time which I discussed earlier, could not be predicted with certainty. History has given us several examples where the decay of weapon parts was more insidious and, rather than being picked up by our extensive stockpile surveillances, was only discovered during an actual test of the warhead, or a similar device. Yet in those cases, until the problems were discovered, confidence in the weapon system had been undiminished.

A continuing test program not only allows us to check our confidence in both our materials and manufacturing processes, but it is essential to calibrate the people who must design and build our nuclear weapons. The judgments which must be made as to whether there are serious problems, and whether a test will be required to identify or correct them, are critical. We can make those judgments well today, because the personnel are deeply immersed in an on-going R&D program. Were this not the case, all of us, both you and the scientists responsible for such warhead decisions, would be lulled into a false sense of security, believing that "what we don't know, won't hurt us". I need not elaborate further on that folly, but the history of nuclear weapons as well as other human endeavors provide many examples to the contrary.

The ability to test weapons effectiveness against changes in Soviet targets would be severely limited by a comprehensive test

ban, along with our ability to adequately evaluate changes in the threat against us. The "window of vulnerability" in limited survivability of our land-based forces to a Soviet counterforce strike has not yet been closed. But future changes in their forces could once again reopen it. Similarly, Soviet anti-ballistic missile research could undermine our retaliatory capability in significant and grave ways, all the more serious if we have no capability to restructure or improve our forces against the threat.

A comprehensive test ban would limit us from effectively developing a strategic defense of our own. Some of the most promising concepts being examined today use nuclear weapon outputs to power them. Development of these new technologies and measurements of their effectiveness against re-entry vehicles cannot be completed without testing. The still burning issue as to whether any missile defense architecture could survive nuclear precursors or even direct nuclear attack could not be dealt with in the absence of testing.

ESTIMATING THE UNCERTAINTIES

For at least the past twenty years, the concept of deterrence has been effective in preventing conflicts from escalating into world war. Note that I limit the time period to far less than the forty-one years since WWII. For the first twenty or so years, the U.S. as a nation enjoyed a clear superiority over the Soviet Union and other nations in terms of

our nuclear forces. That there was no world war (nor any nuclear conflict) during that period is attributable to the fact that the U.S. is not an aggressor state. However, for the most recent twenty years a different principle has controlled - one I like to call "Mutual Assured Deterrence". We are willing to be deterred from attacking the Soviet Union by the likely destruction that would ensue for us, but only if we can be assured that the Soviet Union is similarly deterred from attacking us. The concept of "Mutual Assured Deterrence" became a philosophical notion only well after it was a condition in fact. Although we can well explore other formulae to guarantee peace, there may in fact be no better principle than mutually assured deterrence.

The stability which has resulted could of course be undermined if there were major changes in the equality of the deterrence equation. I believe a comprehensive test ban could itself undermine this stability on two accounts. First, we could believe, though we could not prove, that our strategic weapons could be relied upon to deter Soviet aggression, while in fact they had degraded significantly. Secondly, the Soviet Union could judge that their own weapons, due to such factors as their higher throw weight, were in fact in a significantly superior position. Because of their secretive, controlled society the condition of Soviet weapons could well be backed up (and repairs effected) by clandestine testing - something not possible in our open society. Thus, there is a fundamental asymmetry between our systems; one which verification technologies have so far been

unable to cure.

I would ask you to question why we should be willing to accept such uncertainties when our national survival hangs in the balance. Isn't the price for accepting a comprehensive test ban far too great based on the perceived benefits?

The proponents of a comprehensive test ban, while usually glossing over the uncertainties to our security which come with the package, are hard pressed to state actual gains. Recently they have argued that continued testing by the superpowers actually encourages other states to develop nuclear weapons. I question this thesis. The driving forces for other sovereign nations are fears for their own security rather than any superpower activities. While non-proliferation goals might appear laudable from a global viewpoint, we should not risk the future security of our own nation on such a gesture, particularly since this would be largely a hollow gesture in its ability to influence other nations. The gesture could in fact backfire if those friends and allies who depend on America's nuclear umbrella were to begin to doubt its reliability because of our inability to keep that force strong through testing. They might then, if they had strong fears for their national security, want to develop nuclear weapons of their own.

In summary, underground nuclear testing is an essential part of guaranteeing the operability and hence the deterrent value of U.S. nuclear forces. In a world which is not static, nor can ever be so, we must be able to respond to changes and perpetually

restore mutual assured deterrence if we are to guarantee the peace. We cannot afford to live with the uncertainties which a comprehensive test ban would create.

C. PAUL ROBINSON

C. Paul Robinson received his PhD in Physics from Florida State University in 1967 and joined the Los Alamos Scientific Laboratory (now the Los Alamos National Laboratory) as a nuclear physicist in the Nevada Test Division. In 1968-69 he was Chief Test Operator of the Nuclear Rocket Test Program. In 1970, he joined the Advanced Concepts Group in Los Alamos. He was Technical Director of the Laser Isotope Separation program from its inception in 1972, advancing to the position of Associate Division Leader in the Laser Research Division. In 1976, he was named to head, as Division Leader, the newly formed Applied Photochemistry Division. This technology effort combined several disciplines and performed advance research in laser-induced chemistry, development of new lasers, spectroscopy, and laser isotope separation. On February 1, 1981, Dr. Robinson assumed the post of Associate Laboratory Director for National Security Programs. He was responsible for the Los Alamos National Laboratory's programs in nuclear weapons research, development, underground testing and stockpile maintenance; strategic defense initiatives; inertial confinement fusion; nuclear materials supply and safeguards; advanced conventional weapons; arms control and verification activities; and other defense-related efforts. With the growth of these programs to an annual operating budget exceeding \$600M and 75% of the Laboratory's efforts, he was named Principal Associate Director in 1984.

In December of 1985, he joined Ebasco Services Incorporated in New York as Group Vice-President and Principal Scientist. He

is responsible for Advanced Technology and Special Projects. Ebasco provides engineering, consulting, environmental, construction, quality assurance and advanced technology services to electric utilities, energy-intensive industries and government agencies throughout the world. Its parent company, Dallas-based ENSERCH Corporation, is a diversified energy, engineering and construction company.



PREPARED STATEMENT OF JOHN S. FOSTER, JR.

Mr. Chairman and members of the Committee I appreciate the opportunity to contribute to your deliberations on various proposals to ban the testing of nuclear explosives.

This subject of comprehensive test ban has had an extensive record of debate since the 1950's, a great deal of which has recently been presented to the Congress. Looking over testimony of the past year or so, I conclude that most of the really substantial points have been made in one testimony or another. This record is available to you. Therefore, it seems to me most important not to try to make new arguments, but rather to find a coherent framework for analyzing the significance of the various points on both sides that have already been made. I should note that I have had no official responsibility for these matters since 1973, although I believe that I have kept up well on the various facets of the argument and the relevant technological developments. Prior to that time I was a member of the Livermore staff designing nuclear explosives, director of that laboratory and then Director of Defense Research and Engineering, intricately involved in the details of a wide-range of testing programs and in our responses to the moratorium of 1958 to 1961.

My approach to trying to set a framework for the important points will be to analyze the arguments for the comprehensive test ban by examining the most important facts and realities pertaining to a test ban and its results that we can state with some confidence, then I shall try to derive logical consequences from those facts, which then lead to some arguments against a test ban as well.

As I understand them, four principal arguments have been presented in favor of a comprehensive test ban:

1. The absence of testing necessarily injects in the minds of military strategists and government decision makers some uncertainty as to the reliability and performance of their strategic nuclear weapon forces. However, this uncertainty is not symmetric. That is, a nation considering launching an offensive first-strike would need a much higher degree of confidence in the reliability of its nuclear weapons. Therefore, any decline in confidence on both sides would tend to be stabilizing, since it would reduce the confidence of either side that a first-strike could succeed.
2. A comprehensive test ban could be a palpable next step towards global strategic arms controls and reductions. We need major, mutually beneficial steps like a ban to establish the confidence necessary for more difficult, more complex arms control issues.
3. Banning nuclear weapons testing stops the development of new kinds of higher technology nuclear weapons. Therefore, stopping testing represents a straightforward way to halt the development of high technology nuclear weaponry, which is a principal driver of the strategic arms race.

4. Continued testing promotes nuclear proliferation. Weapons testing by the superpowers acts as an incentive to the development of nuclear weapons in third nations, since those nations perceive there is no genuine interest in curtailing nuclear weapons by the superpowers. The superpowers have frequently appealed to third nations for restraint and promised restraint in the future on their own part; however, if this restraint is not forthcoming, the third nations will feel they have been duped and will develop their own nuclear forces

With these arguments as the background, let me now offer a series of facts about nuclear weapons and nuclear weapons testing which I believe will be acknowledged as true by both the advocates and the critics of a comprehensive test ban. Within the framework of these facts, then, perhaps we can evaluate the strength and validity of the arguments above, and consider arguments against a ban as well.

The first and obvious fact is that a comprehensive test ban eliminates no nuclear weapons of itself and does not necessarily lead in any logical way to the reduction of stockpiles. Whether or not it is true that a test ban would create a confidence level that might lead to future arms control negotiations or successes, logically the test ban itself does not lead to any particular kinds of reductions or even suggest the directions in which they might most practically be considered.

The second fact is that nuclear weapons decay as a function of time on the shelf. The rate at which they decay, and the extent of deterioration of their performance at various times, are strong functions of the particular design and construction of the weapons themselves. Thus one cannot say, for instance, that nuclear weapons tend to degrade after ten years on the shelf or 20 years on the shelf or whatever. But one can say with high confidence that after a period of some years many weapons will have degraded in performance, and that eventually virtually all weapons will suffer degradation of performance. This degradation, whatever its degree, is the source of the lack of confidence mentioned in argument number one above. Exactly how high the uncertainty levels on either side will be, or how little confidence decision makers will begin to place in the weapons, remains problematic; but the fact that the performance of the weapons will decay, in some unpredictable fashion, can hardly be contested.

The third fact has frequently been commented on by various government and laboratory officials in a number of different ways. This fact is that the U.S.²⁰ capability to design, construct, repair or repackage nuclear weapons declines very strongly if testing ceases. One might expect that such decline would be relatively slow for the first three years and then would accelerate over a decade or so after that. However, our experience at the end of the testing moratorium in 1961 was that our capability to test had declined by a very considerable amount in only three years, and a crash program was necessary to get us in the field again within a year. But the Soviets were able to field a rather extensive test series quite capably while we suffered under great difficulties. This demonstrated an important asymmetry in the maintenance of nuclear weapons capabilities.

There are several factors which cause this difference in the decline of capability. The first is, obviously, that in our society, it is difficult to keep the really talented people working in a field of experimental science in which there are not going to be any experiments. There are always excellent opportunities for other programs to work on, especially for the very brightest people, the ones we have the most trouble recruiting and retaining even when test series are going on. The Soviets, on the other hand, are not faced with this problem. They have the authority to tell their scientists which programs they will work on. Another problem is that our judgment on the various physical problems which arise in design, redesign and repair becomes rather poor without tests. Even when we are conducting nuclear tests, such as we now are, practically every test we do produces some surprises, especially if the results are examined in great detail. Tests of new weapons and tests of new experimental concepts virtually always produce surprises. The fact is that there are a great many things about the details of the operations of these weapons that are not yet understood. However, if we do not have the tests to continue to provide sobering evidence of our ignorance, it is very easy to become overconfident about one's understanding and ability to predict. Small-scale experiments on components do very little to solve this problem. In fact, they may actually add to the specious sense of confidence, since a correct prediction of the operation of a particular component may mean little or nothing to the predictability of the performance of the complete weapon.

One particular aspect of this problem which gains increasing importance is our reliance on computers and computer simulations. It is true that these computer models are becoming better all the time. It is also true that their predictions are usually among those confounded by the surprise results of underground tests, and that is how we decide they need to be further improved. An understanding of the physics of any particular kind of experiment, of which nuclear weapon detonations are merely one specific example, based upon numerical simulations is simply a simulated understanding.

The fourth fact, which is rather seldom mentioned, but which I believe should be highlighted, is that the US currently has no readiness-to-test program to support the resumption of atmospheric testing should the Soviets resume such testing. But the Senate ratification of the atmospheric test ban was specifically predicated upon the maintenance of a strong readiness-to-test program in our national laboratories and the Defense Nuclear Agency. That program lasted perhaps five to ten years, but despite prior Senate insistence, has now disappeared completely. Thus if the Soviets were to resume atmospheric testing without notice, as they did in 1961, it would probably take at least three years before we could field a useful, credible test series. The Safeguard provision for readiness to resume testing in the atmosphere has failed.

The fifth fact is that even in the face of a comprehensive test ban, rigorously observed by both sides, the fabrication of new nuclear weapons can

and will be likely to continue. The absence of testing merely restricts the development of new types of nuclear weapons and warheads. It does not prevent either side from continuing to construct more weapons of types that side has already designed and tested.

Furthermore, the ban does not prevent the development of new delivery systems for nuclear weapons. Thus new weapon systems can and in the absence of other restrictions will continue to be designed and produced. A ban on nuclear weapons testing does not restrict the growth of defense technology in general; it only makes new strategic delivery systems less efficient because they cannot be designed to carry optimum nuclear warheads, since we will not have developed these.

Now what conclusions can we reasonably draw from this set of facts? These conclusions will lead to some arguments against a comprehensive ban.

First, I think it is obvious (and both sides of the argument agree) that confidence in the reliability of our nuclear stockpile will decline as time passes. The same thing will be true to some extent of the Soviets confidence. If our confidence in our stockpile declines, and we have a way of evaluating how much it has declined, it is very likely that the Soviets will gain accurate knowledge of that perception. That is to say, they will know what we will know about the unreliability of our stockpile; the converse is not likely to be the case.

In fact, it is entirely likely that in our system and possibly the Soviets, the word on actual decline in stockpile reliability may never get to the top. Expecting the highest level officials to gain the complete details of unreliability of these systems is, as the shuttle disaster has illustrated, an optimistic view of things. This tends to weaken the argument that Soviet first-strike will be strongly discouraged by perceptions of low reliability; such perceptions may never materialize at the higher levels of the Soviet command structure.

On the other hand, the Soviet leadership acts very seriously about their nuclear weapons systems. If they believe there is a reliability problem, I think we can be confident they will do something about it. They have several options. First, they may just go for more weapons of possibly several different types against the affected target set. In other words, they might just build more. However, they might also choose to fix the problem. They might fix it by simply abrogating the agreement and proceeding to test. Under these circumstances, they are very likely to be in a better situation than we will be since their design laboratories, as I indicated, are likely to be much healthier. However, they also might choose to violate the agreement covertly. If the reliability problem can be addressed by underground tests of only a few kilotons, I believe they could perform such tests without our being able to prove they have done so. In spite of the expected improvement of detection capabilities, I think that if some final agreement is made, the number of false alarms will make it impossible to confidently determine that

they are not testing at low yield. However, if they should find a need to test at high yield, they have adequate capabilities for deep space experiments in regions where we have no capabilities for determining that they have tested.

On the whole, it seems illogical to plan unreliability into strategic force operations as a means of reducing tensions. No one can predict accurately the psychological effects on leaders (particularly leaders whose identities we do not know) of creating uncertainties in the operations of their own forces. Look at it this way: If we wish to introduce unreliability into the force, why don't we merely stop worrying about the state of our command and control systems? Or, why don't we enter into an agreement with the Russians that would debilitate both of our command and control systems? Clearly such a course would be irrational. Yet it is logically equivalent to the function proposed here for a comprehensive test ban.

It also seems illogical to propose that we will gain some benefits from reducing our confidence in our nuclear stockpiles, and then to follow that proposal with further proposals to reduce the numbers of weapons. This is essentially equivalent to placing the total operational credibility of our deterrent in doubt voluntarily. If the other side does not have such doubts, for any reason, we will have created an extremely unstable situation. In fact, it has been a strong principle of arms control thus far, that reductions in total numbers of deterrent force weapons should be accompanied by increased confidence in the survivability and reliability of those weapons. That is why we want to increase security of command and control; that is why we are worried about bomber and ICBM survivability.

In summary of this part of the discussion, it seems to me that the argument in favor of the comprehensive test ban that arises from a perceived value of uncertainty is fallacious. Such uncertainties are not fundamentally desirable, and to the extent that they are asymmetrical they tend to work to the benefit of the Soviet Union.

Similarly, the argument for a CTB as a next step in arms control seems to fail the same way. If we start by introducing uncertainties and lack of confidence in our deterrent force, we will have introduced a disincentive rather than an incentive for a reduction of numbers of strategic weapons. Nothing will have been eliminated by this first step; tensions will not be reduced. The incentive works the wrong way. Thus the gesture is at best futile; at worst counterproductive to arms control.

Now with respect to the argument concerning stopping technology -- the discussion of the facts above already, I think, make this situation clear. Since it will still be possible to build new strategic delivery systems, the US will be forced by the test ban to choose between not modernizing its strategic forces or building new weapon systems that are more expensive than they need to be. This seems to me to make the arms race worse, not better. Again, if the objective is somehow to stop the development of new kinds of weapons systems, this method (hoping to do it easily through a single limitation) is not productive and may very well be counterproductive. It does not address the problem directly, and, like many such simple solutions to complex problems, has very little to do with the actual solution of the problem.

With respect to the proliferation argument, we must expect that the third nations whom we wish to influence will notice that, although testing has stopped, both of the superpowers continue to develop new weapon systems, employing new nuclear weapons. It would be naive to assume that they are so naive as to mistake the difference and presume that we are not continuing to modernize and develop our nuclear forces. Thus such an action would be only cosmetic in terms of proliferation resistance. The third nations will decide whether or not to develop nuclear weapons by deciding what is in their own best interests, just as they always have. Thus far, our foreign policy and military policy have succeeded largely in discouraging such proliferation, where such discouragement was possible. We must continue to rely on those policies, and not expect that the internal perceptions of other nations' interests will be changed by our establishing a largely public relations posture.

So, finally, I find that if we examine the arguments in favor a comprehensive nuclear test ban in terms of their logical justification and their symmetric application, they are found wanting on both counts. The logical justifications for such a ban seem not merely weak but inherently fallacious. It also seems clear to me that, in several critical aspects, the effects of such a ban will not be symmetric between us and the USSR, and will generally act in their favor.

For the foreseeable future our strategic security will depend upon our possession of a deterrent whose basis is nuclear weapons. That means that we will maintain a stockpile of these nuclear weapons, and will maintain and upgrade the weapon systems that employ them. I cannot see how we can think it in our best interest to reduce our strategic weapons to a few thousand or even a few hundred in our possession and prepared for use, while at the same time putting ourselves voluntarily in a position in which we no longer have, anywhere in the country, people who really understand how those weapons work, how they are made, and what they will do.

6/25/86

PREPARED STATEMENT OF ALTON FRYE

NUCLEAR TEST RESTRAINTS AND AMERICAN SECURITY:
CAN WE FORGE A CONSENSUS?

MR. CHAIRMAN, I APPRECIATE THE OPPORTUNITY TO DISCUSS WITH THE COMMITTEE AN ISSUE WHICH HAS GREAT BEARING ON THE SECURITY OF OUR NATION --- AND ON THE HEALTH OF ITS BODY POLITIC. THE PERPETUAL DISPUTES OVER NUCLEAR TESTING HAVE CONCERNED THE SENATE AND THE AMERICAN PEOPLE FOR MORE THAN A QUARTER CENTURY.

MUCH HAS CHANGED IN THAT PERIOD --- TECHNOLOGICALLY, POLITICALLY, STRATEGICALLY. IT BEHOOVES US TO EXAMINE AGAIN, AND WITH FRESH MINDS, WHETHER OR NOT THE UNITED STATES WILL BE SAFER OR LESS SECURE BY CONTINUING TESTS OF NUCLEAR WEAPONS. BUT IT ALSO BEHOOVES US TO REMEMBER THAT SUCH AN ISSUE IS FUNDAMENTALLY A POLITICAL ONE. QUESTIONS OF VERIFICATION CAPABILITIES, OF STOCKPILE RELIABILITY, OF FUTURE TECHNOLOGICAL OPTIONS ARE IMPORTANT BUT SUBORDINATE ELEMENTS OF A COMPLEX POLICY JUDGEMENT.

THERE ARE RISKS WITH CONTINUED NUCLEAR TESTING AND THERE ARE RISKS WITHOUT CONTINUED NUCLEAR TESTING. THE CHOICE OF WHICH RISKS THE NATIONS SHOULD BEAR IS PERHAPS THE GRAVEST RESPONSIBILITY OF ELECTED OFFICIALS. EQUALLY IMPORTANT, AS YOU AND YOUR COLLEAGUES WEIGH THAT

CHOICE, IS THE TASK OF SHAPING A POLICY THAT CAN OVERCOME THE LONGSTANDING DIVISION AMONG AMERICANS ON THIS QUESTION. I BELIEVE THE MOMENT HAS COME WHEN IT IS POSSIBLE TO DO SO. AND IN THE QUEST FOR THE MAJOR STRATEGIC ARMS REDUCTIONS WHICH PRESIDENT REAGAN HAS PROPOSED, A NEW APPROACH TO ISSUES OF NUCLEAR TESTING COULD PROVE A CATALYST OF HISTORIC SIGNIFICANCE.

TWENTY THREE YEARS AGO THE SENATE PLAYED A DECISIVE ROLE IN CONFINING NUCLEAR TESTS TO UNDERGROUND EXPLOSIONS. SENATORS THOMAS DODD AND HUBERT HUMPHREY --- BOTH MEMBERS OF THIS COMMITTEE --- WON THE SUPPORT OF A CRUCIAL GROUP OF SENATORS FOR A COMPROMISE PLAN TO BREAK THE DEADLOCK OVER A COMPREHENSIVE NUCLEAR TEST BAN. THAT DEADLOCK HAD GROWN ACUTE AFTER THE SOVIETS ABRUPTLY RESUMED TESTING IN 1961 AFTER A THREE-YEAR MORATORIUM. IN THE FIFTEEN MONTHS AFTER THE SOVIETS BEGAN TO TEST AGAIN, THE COMPETITION INTENSIFIED. THE SOVIET UNION CONDUCTED OVER 90 TESTS IN THAT PERIOD --- AND THE UNITED STATES CONDUCTED OVER 100, DISPROVING SUGGESTIONS THAT THE MORATORIUM HAD SERIOUSLY ERODED THE CAPACITY OF OUR NUCLEAR LABORATORIES.

THE DODD-HUMPHREY RESOLUTION OF 1963 MADE CLEAR THAT, WHILE OUR ABILITY TO VERIFY A COMPLETE BAN ON TESTS APPEARED INADEQUATE, THE SENATE WOULD WELCOME A BAN ON TESTS IN THOSE ENVIRONMENTS WHICH COULD BE MONITORED WITH CONFIDENCE. THAT SENATE INITIATIVE ANTICIPATED AND INVITED THE LIMITED TEST BAN TREATY CONCLUDED LATER THAT YEAR.

TODAY A SIMILAR OPPORTUNITY EXISTS FOR THE SENATE TO TAKE THE LEAD IN MOVING NUCLEAR TEST POLICY TO THE NEXT STAGE. IN RECENT MONTHS BOTH HOUSES OF CONGRESS HAVE URGED RATIFICATION OF THE THRESHOLD TEST BAN TREATY AND RESUMPTION OF NEGOTIATIONS FOR A COMPREHENSIVE TEST BAN (CTB).

IT IS EVIDENT, HOWEVER, THAT THE ADMINISTRATION WILL NOT SEEK A CTB, ALTHOUGH IT SAYS SUCH A TREATY REMAINS A GOAL FOR THE FUTURE. THE ADMINISTRATION NOW INSISTS THAT NUCLEAR TESTING MUST CONTINUE SO LONG AS THE UNITED STATES RELIES ON NUCLEAR WEAPONS FOR DETERRENCE.

UNLESS WE CAN FRAME A CREATIVE COMPROMISE, THERE IS LIKELY TO BE PROTRACTED LEGISLATIVE-EXECUTIVE DISCORD OVER THIS ISSUE. THE UNITED STATES IS ALSO LIKELY TO REMAIN ISOLATED INTERNATIONALLY ON THIS ISSUE, AS IT HAS BEEN FOR SOME TIME NOW. AND OUR COUNTRY MAY BE CEDING THE HIGH GROUND TO THE SOVIET UNION, WITH ITS APPARENTLY MORE FORTHCOMING POSITION REGARDING COOPERATIVE VERIFICATION OF A CTB, INCLUDING ON-SITE INSPECTION AND INTERNATIONAL MONITORING.

TO FORESTALL THESE UNWELCOME CONSEQUENCES, WE NEED TO FOCUS VERY PRECISELY ON THE POSSIBILITIES FOR RECONCILING THE DIFFERENCES BETWEEN CONGRESS AND THE ADMINISTRATION. WE ALSO NEED TO CONSIDER WAYS IN WHICH ACTION ON NUCLEAR TESTING CAN BE TAILORED TO FACILITATE THE LARGER OBJECTIVE OF REDUCTIONS IN DEPLOYED FORCES. THE OPPORTUNITIES FOR DOING SO ARE GREATER THAN GENERALLY REALIZED.

LET ME PREFACE MY RECOMMENDATIONS BY NOTING THAT THE EARLIER DISPUTES OVER VERIFICATION OF TEST RESTRAINTS HAVE RECEDED SUBSTANTIALLY AS TECHNICAL CAPABILITIES HAVE EVOLVED. I LEAVE TO OTHERS ON THE PANEL A DETAILED ASSESSMENT OF TODAY'S STATE OF THE ART IN VERIFICATION. SUFFICE IT TO SAY THAT THOSE WHO PREVIOUSLY BELIEVED, AS I DID IN 1963, THAT A CTB WOULD NOT BE PRUDENT BECAUSE OF UNCERTAINTIES ABOUT ITS VERIFIABILITY ARE NOW OBLIGED TO REEVALUATE THAT CONCLUSION. THE POINT I WANT TO EMPHASIZE IS THAT IMPROVEMENTS IN VERIFICATION CAPABILITIES HAVE HAD IMPORTANT POLITICAL IMPACT.

FOR EXAMPLE, NORWEGIAN SCIENTISTS AND OFFICIALS HAVE BEEN INVOLVED IN A COLLABORATIVE EFFORT WITH US TO INSTALL AND OPERATE ADVANCED SEISMIC FACILITIES. AS THEIR CONFIDENCE IN THE SYSTEM'S POWER TO DETECT SOVIET UNDERGROUND TESTS HAS GROWN, SO, TOO, HAS THE STRENGTH OF NORWEGIAN ARGUMENTS THAT A CTB WOULD BE FEASIBLE, VERIFIABLE, AND WORTHWHILE. SIMILARLY, THE GERMAN TECHNICAL COMMUNITY'S RECOGNITION OF PROGRESS ON TEST MONITORING HAS FED THE DEVELOPMENT OF FIRMER SUPPORT IN BONN FOR RESUMPTION OF CTB NEGOTIATIONS. CHANCELLOR KOHL HAS VOICED THOSE SENTIMENTS IN PUBLIC AND, I UNDERSTAND, DIRECTLY IN A PERSONAL LETTER TO PRESIDENT REAGAN. AT HIS PRESS CONFERENCE ON APRIL 11, THE CHANCELLOR SAID, "A NUCLEAR TEST BAN REMAINS AN IMPORTANT GOAL FOR THE FEDERAL GOVERNMENT [OF GERMANY].... IN THE VIEW OF THE FEDERAL GOVERNMENT, VERIFICATION POSSIBILITIES SHOULD NO LONGER STAND AS THE CHIEF OBSTACLES TO AN AGREEMENT.... ACCORDINGLY, BOTH SIDES COULD CONSIDER A TRANSITIONAL SOLUTION FOR A LIMITATION OF TESTS. FOR EXAMPLE, THEY COULD SET AGREED INTERVALS FOR NECESSARY PROOF TESTS OF NUCLEAR WEAPONS AND, IN THE CONTEXT OF NEGOTIATED REDUCTIONS OF NUCLEAR WEAPONS, GRADUALLY STOP THEM ENTIRELY."

SENIOR BRITISH SCIENTISTS ARE ALSO CONFIDENT THAT, EVEN WITHOUT COOPERATIVE MEASURES, THE TESTING THRESHOLD COULD BE LOWERED DRASTICALLY FROM THE CURRENT LEVEL OF 150 KILOTONS.

IN SHORT, THE EMERGING CONSENSUS IN THE INTERNATIONAL SCIENTIFIC COMMUNITY IS AFFECTING THE POLITICAL VIEWS OF OTHER GOVERNMENTS. SINCE THE UNITED STATES HAD CONSISTENTLY DECLARED ITS SUPPORT FOR A CTB IF IT COULD BE VERIFIED, WE ARE PAYING A PRICE IN CREDIBILITY BY SLIDING OFF THAT POSITION NOW THAT OUR VERIFICATION OBJECTIONS SEEM LESS COMPELLING.

WE INCREASE THAT PRICE WHEN OFFICIALS STRAIN THE CASE BY ARGUING THAT A CTB MIGHT ACTUALLY SPUR NUCLEAR PROLIFERATION BY RAISING DOUBTS ABOUT AMERICAN RELIABILITY AMONG THOSE WHO NOW FIND SHELTER UNDER THE U.S. NUCLEAR UMBRELLA. APART FROM THE FACT THAT THE INTERNATIONAL COMMUNITY PERSISTENTLY CALLS FOR A CTB AS A BARRIER AGAINST PROLIFERATION --- WITNESS THE FINAL DECLARATION OF LAST YEAR'S NONPROLIFERATION TREATY REVIEW CONFERENCE --- ONE HAS A BASIC STRATEGIC REASON FOR DISCOUNTING THE CONTENTION THAT A TEST BAN WOULD BY SOME PERVERSE LOGIC PROMPT OTHER STATES TO ACQUIRE NUCLEAR WEAPONS. HOW LIKELY IS IT THAT AN AMERICAN ALLY WOULD PREFER TO TRADE THE SECURITY IT DERIVES FROM THE MASSIVE AND HIGHLY SOPHISTICATED U.S. DETERRENT, REFINED THROUGH MORE THAN 800 NUCLEAR TESTS, FOR RELIANCE ON AN UNTESTED AND PRIMITIVE NUCLEAR FORCE OF MINUSCULE PROPORTIONS? HAVING JUST PARTICIPATED IN A THREE-YEAR INDEPENDENT STUDY OF PROLIFERATION PROBLEMS, CONDUCTED BY PARALLEL EUROPEAN AND AMERICAN PANELS, I HAVE YET TO FIND ANY KNOWLEDGEABLE FIGURE IN EUROPE WHO TAKES THAT ARGUMENT SERIOUSLY.

YET FOR NOW IT MAKES LITTLE DIFFERENCE THAT INCREASING NUMBERS OF NATIONAL SECURITY PROFESSIONALS HAVE CONCLUDED THAT A CTB WOULD BE VERIFIABLE AND VALUABLE. THE ADMINISTRATION HAS BASED ITS DECISION NOT TO PURSUE A COMPREHENSIVE BAN ON THE THESIS THAT TESTING IS NEEDED TO MAINTAIN CONFIDENCE IN THE RELIABILITY OF CURRENT WEAPONS. THE PRACTICAL QUESTION IS WHETHER WE CAN FORGE A POLITICAL CONSENSUS ON A PLAN THAT ACCOMMODATES THE ADMINISTRATION'S STATED CONCERNS, WHILE ADVANCING THE PROCESS OF NEGOTIATING MUTUAL STRATEGIC RESTRAINT. I AM PERSUADED THAT WE CAN.

TO NOURISH THAT PROCESS, THERE IS A NEED TO DEMONSTRATE THAT THE

UNITED STATES AND THE SOVIET UNION CAN ACHIEVE AND IMPLEMENT CONCRETE AGREEMENTS TO REGULATE THEIR STRATEGIC ACTIVITIES. THE SUCCESSION OF UNRATIFIED ACCORDS BETWEEN THE SUPERPOWERS IS A BALEFUL OMEN. PERHAPS THE BEST CHANCE OF BREAKING THE CYCLE OF AGREEMENTS NEGOTIATED LABORIOUSLY OVER MANY YEARS AND THEN LEFT TO HANG IN LIMBO LIES WITH THE THRESHOLD TEST BAN TREATY AND THE PEACEFUL NUCLEAR EXPLOSIONS TREATY.

SENATOR SAM NUNN AND OTHERS HAVE MADE A THOROUGHLY REASONABLE PROPOSAL. THE ADMINISTRATION SHOULD SPECIFY THE VERIFICATION ENHANCEMENTS IT SAYS ARE NECESSARY IN THOSE AGREEMENTS AND THE SENATE SHOULD THEN CONSIDER WHETHER TO INCORPORATE THEM AS RESERVATIONS TO A RESOLUTION OF RATIFICATION.

BUT ACTION ON THE TTB AND PNE AGREEMENTS PRESENTS A GREATER OPPORTUNITY FOR THE SENATE TO COAX NEGOTIATIONS IN A CONSTRUCTIVE DIRECTION. IT COULD DO SO BY ENDORSING THREE RELATED IDEAS. THESE PROPOSALS WOULD MEET THE ADMINISTRATION'S DEMAND FOR SO-CALLED RELIABILITY TESTS OF THE EXISTING INVENTORY, LAY THE GROUNDWORK FOR COOPERATIVE VERIFICATION ARRANGEMENTS, AND RESPOND TO OUR INTERNATIONAL COMMITMENTS UNDER THE NON-PROLIFERATION TREATY AND OTHER ACCORDS TO MAKE MEANINGFUL REDUCTIONS IN THE NUCLEAR PROGRAMS OF THE TWO SUPERPOWERS.

FIRST, THE UNITED STATES SHOULD PROPOSE AN ANNUAL QUOTA ON THE NUMBER OF TESTS TO BE CONDUCTED BY EACH PARTY TO THE AGREEMENT. FIVE TESTS A YEAR WOULD BE AMPLE TO CHECK FOR PROBLEMS IN THE STOCKPILE PRESENTLY DEPLOYED. DR. HERBERT YORK, FORMER DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING, ESTIMATES THAT IN FACT ONLY ABOUT ONE TEST A YEAR HAS BEEN A PROOF TEST.

SECOND, WE SHOULD URGE A DECLINING THRESHOLD IN THE SCALE OF PERMISSIBLE TESTS. FORMER SECRETARY OF DEFENSE HAROLD BROWN AND OTHER EXPERTS HAVE EMBRACED THE NOTION THAT THE 150 KILOTON CEILING OF YIELDS COULD BE TRIMMED TO 10 KILOTONS OR LESS. (DR. HANS BETHE HAS SAID THAT "ZERO-YIELD" TESTS WOULD BE SUFFICIENT TO ASSURE THE OPERABILITY OF KNOWN DESIGNS.) AT THE 10 KILOTON LEVEL, TESTS SHOULD STILL BE DETECTABLE, BUT MAJOR INNOVATIONS WOULD BE DIFFICULT.

THIRD, COUPLED WITH THESE STEPS SHOULD BE A PROPOSAL TO CONDUCT A FIVE-YEAR EXPERIMENT TO DEMONSTRATE THE UTILITY OF COOPERATIVE VERIFICATION MEASURES. WHILE GENERAL SECRETARY GORBACHEV HAS LINKED HIS REFERENCES TO ON-SITE INSPECTION TO A MORATORIUM ON TESTS, THE SOVIETS SHOULD UNDERSTAND THE NEED FOR BUILDING CONFIDENCE IN VERIFICATION ARRANGEMENTS. IN FACT, THAT CONFIDENCE WILL BE GREATER IF SEISMIC AND OTHER DEVICES ARE EXERCISED ALONG WITH ON-SITE INSPECTION PROCEDURES DURING A PERIOD WHEN THERE ARE AT LEAST SOME TESTS.

PROPOSALS OF THIS NATURE HAVE IMPLICATIONS FAR BEYOND THE REALM OF NUCLEAR TESTING. BOTH MOSCOW AND WASHINGTON ARE TALKING IN TERMS OF DEEP CUTS IN THEIR ARSENALS. IF THOSE REDUCTIONS ARE TO COME ABOUT, IT IS IMPERATIVE THAT THE TWO SIDES START TO GAIN EXPERIENCE WITH MORE ELABORATE VERIFICATION PROVISIONS. NUCLEAR TEST RESTRAINTS OFFER AN ALMOST IDEAL SUBJECT FOR LEARNING HOW TO VERIFY MORE FAR-REACHING AGREEMENTS. SHRINKING THE THRESHOLD AND SETTING A STRICT QUOTA WOULD LEND NEW FORCE TO A PROPOSAL FOR SUCH AN EXPERIMENT.

ON THE BASIS OF THIS EXPERIMENT THE SUPERPOWERS WOULD BE IN A MUCH BETTER POSITION TO DETERMINE WHETHER AND HOW SOON TO ESTABLISH A COMPREHENSIVE TEST BAN. IN PRINCIPLE, THEY COULD REACH THAT GOAL BY

FURTHER REDUCTIONS IN EITHER THE THRESHOLD OR THE QUOTA. IN THE MEANTIME, HOWEVER, EMBARKING ON THIS REGIME COULD GIVE REAL MOMENTUM TO SOVIET-AMERICAN DIPLOMACY. IT COULD PROVIDE THE KIND OF MAJOR SUCCESS SO LONG ABSENT FROM BILATERAL BARGAINING ON THESE TOPICS. AND FAR FROM DIVERTING ENERGIES FROM THE AMBITIOUS GOAL OF FORCE REDUCTIONS, IT COULD REINFORCE EFFORTS IN THAT DIRECTION, BOTH POLITICALLY AND TECHNICALLY.

ABOVE ALL, A PROGRAM OF THIS NATURE WOULD DEFINE THE COMMON GROUND ON WHICH AN OVERWHELMING MAJORITY OF AMERICANS CAN RALLY. IT WOULD NOT SATISFY THOSE WHO DEMAND AN IMMEDIATE HALT TO ALL NUCLEAR TESTING OR THOSE WHO INSIST THAT THERE BE NO RESTRAINTS ON TESTING. BUT IT WOULD RESPOND TO THE PRINCIPAL REQUIREMENTS STATED BY THE ADMINISTRATION; THE OBJECTIONS TO A CTB DO NOT APPLY TO A QUOTA BAN UNDER A REDUCED THRESHOLD. AND FOR THOSE WHO BELIEVE THAT BOTH ROBUST DEFENSE AND NEGOTIATED RESTRAINT ARE ESSENTIAL TO AMERICAN SECURITY, IT WOULD OFFER A POSITIVE AGENDA THAT PROMISES PROMPT RESULTS.

HAVING WORKED WITH MEMBERS OF THE SENATE FOR TWENTY FIVE YEARS, I UNDERSTAND THE GREAT DEFERENCE SENATORS HAVE FOR THE OFFICE OF THE PRESIDENCY AND THE RELUCTANCE THEY FEEL TO ASSERT POSITIONS AT ODDS WITH AN INCUMBENT ADMINISTRATION'S DIPLOMATIC PREFERENCES. SUCH RESTRAINT IS USUALLY ADMIRABLE AND WISE. BUT THERE ARE TIMES WHEN THE SENATE NEEDS TO CONSULT ITS INSTITUTIONAL MEMORY IN ORDER TO JUDGE WHETHER AN EXCEPTION TO SUCH SELF-RESTRAINT IS CALLED FOR.

WHEN ONE CONSIDERS THE CRUCIAL STRATEGIC QUESTIONS OF RECENT YEARS THE SENATE HAS OFTEN BEEN MORE FAR-SIGHTED THAN THE EXECUTIVE BRANCH. IF THE SENATE HAS NOT SLOWED DEPLOYMENT OF ANTI-BALLISTIC MISSILE SYSTEMS IN THE YEARS 1967-72, NOT ONLY WOULD THERE HAVE BEEN NO

CHANCE TO NEGOTIATE THE USEFUL RESTRAINTS OF THE ABM TREATY; THE UNITED STATES WOULD TODAY HAVE DEPLOYED AN OUTMODED AND VULNERABLE ABM SYSTEM WASTING BILLIONS OF DOLLARS AND CONTRIBUTING LITTLE TO AMERICAN SECURITY. IF THE SENATE HAD NOT INSISTED IN 1976 ON A SURVIVABLE BASING MODE FOR THE MX MISSILE, THE UNITED STATES WOULD TODAY HAVE DEPLOYED 3000 HARD TARGET WARHEADS IN 300 VULNERABLE SILOS --- EXACTLY THE KIND OF PROVOCATIVE DEPLOYMENT THE AIR FORCE ITSELF CAME TO REJECT AS DANGEROUSLY DESTABILIZING. AND IF THE UNITED STATES HAD ACTED ON THE SENATE'S ADVICE OF 1970 --- EXPRESSED OVERWHELMINGLY IN THE 72 - 6 VOTE FOR THE BROOKE RESOLUTION --- IT WOULD HAVE PURSUED A MUTUAL BAN ON THE MIRVED BALLISTIC MISSILES THAT HAVE PLACED THE AMERICAN PEOPLE IN UNPRECEDENTED JEOPARDY.

TO SPEAK BLUNTLY, ON THESE AND OTHER CRITICAL ISSUES THE SENATE'S JUDGEMENT HAS BEEN SOUNDER THAN THAT OF THE EXECUTIVE BRANCH. SOME MEMBERS OF THIS BODY HAVE LONGER EXPERIENCE WITH THESE PROBLEMS THAN MANY OF THOSE TENDERING ADVICE TO THE PRESIDENT. I BELIEVE SENATORS SHOULD TRUST THEIR JUDGEMENT AND SHOULD NOT HESITATE TO EXPRESS IT FIRMLY. ONE SOMETIMES WONDERS WHETHER THE BIPARTISAN CONGRESSIONAL EFFORT TO HEAD OFF THE MIRV COMPETITION SHOULD HAVE MOVED BEYOND ADMONITION AND LIMITED THE EXPENDITURE OF FUNDS FOR MIRV TESTING UNTIL A PROPOSAL FOR MUTUAL TEST RESTRAINTS HAD BEEN PRESENTED TO THE SOVIET UNION. SUCH A MOVE SEEMED POLITICALLY IMPRUDENT AT THE TIME, BUT THE POLICY THAT EMERGED PROVED TO BE STRATEGICALLY IMPRUDENT, A VERDICT CONFIRMED BY PRESIDENT REAGAN'S VALID COMPLAINTS ABOUT THE INCREDIBLE SURGE IN THE NUMBERS OF NUCLEAR WARHEADS SINCE THAT TIME.

IN THE CURRENT CASE, CIRCUMSTANCES ARE QUITE DIFFERENT. BOTH HOUSES OF CONGRESS HAVE ALREADY EXPRESSED THEIR CONSENSUS IN SUPPORT OF

RATIFICATION OF THE TTB AND PNE TREATIES. PENDING SUCH RATIFICATION THE UNITED STATES AND THE SOVIET UNION ARE RESPECTING BOTH AGREEMENTS AND IT IS HARD TO SEE WHY AN AGREEMENT WORTH RESPECTING IS NOT WORTH RATIFYING --- ESPECIALLY WHEN DOING SO COULD CONTRIBUTE TO BROADER MOVEMENT TOWARD ACTUAL REDUCTIONS IN SUPERPOWER ARSENALS. PERHAPS CONGRESS SHOULD CONSIDER LIMITS ON FUNDING FUTURE NUCLEAR TESTS UNTIL THE PRESIDENT HAS PRESENTED THOSE AGREEMENTS, ALONG WITH POSSIBLE MEASURES TO IMPROVE THEIR VERIFICATION, FOR ACTION BY THE SENATE. SOMETIMES CONGRESS MUST NOT ONLY EXPRESS A CONSENSUS; IT MUST ENFORCE IT.

ANY SUCH EFFORT MUST OBVIOUSLY BE BIPARTISAN IF IT IS TO EARN THE FULL CONFIDENCE OF THE NATION. THE REPUBLICANS WHO IN 1970 CHALLENGED AN ADMINISTRATION OF THEIR OWN PARTY TO RESTRAIN MIRV --- EDWARD BROOKE, CLIFFORD CASE, JACOB JAVITS AND JOHN SHERMAN COOPER --- WERE JOINED BY MOST OTHER REPUBLICANS AND DEMOCRATS ALIKE, INCLUDING SEVERAL STILL SERVING ON THIS COMMITTEE. A COALITION TO ESTABLISH ADDITIONAL LIMITS ON NUCLEAR TESTING MUST ALSO ENGAGE THE LEADERSHIP OF BOTH REPUBLICANS AND DEMOCRATS.

ONCE AGAIN, AS IN 1963 AND 1970, THE SENATE CAN LEAD OUR PEOPLE TOWARD COMMON GROUND. THE QUARREL OVER NUCLEAR TESTING HAS BEEN WITH US TOO LONG. IT IS TIME FOR AN INITIATIVE TO EASE THE FRICTIONS BETWEEN THE CONGRESS AND THE EXECUTIVE, BETWEEN US AND OUR ALLIES, BETWEEN AMERICANS AND THEIR FELLOW CITIZENS. NO INSTITUTION IS SO WELL PLACED AS THE SENATE TO TAKE THAT INITIATIVE. I URGE IT TO DO SO, AND BY DOING SO TO REJUVENATE THE FALTERING DIPLOMACY OF STRATEGIC RESTRAINT.

PREPARED STATEMENT OF LYNN R. SYKES

ADVANCING UNITED STATES NATIONAL SECURITY INTERESTS THROUGH
VERIFIABLE LIMITATIONS ON NUCLEAR TESTING

Mr. Chairman, members of the Committee, I address you today as a scientist who has been involved in the identification of atomic testing and estimates of the sizes of Soviet weapons tests for the past 25 years. Several recent developments have led to increased Congressional and public interest in limiting atomic testing. These include the passage of resolutions by the Senate and House advocating ratification of the existing Threshold Test Ban and Peaceful Nuclear Explosion treaties and the re-commencement of negotiations toward a full test ban treaty, the announcement in the New York Times on April 2 that the United States Government has revised its procedure for calculating the yields of Soviet weapons tests, the recognition that the U.S.S.R. has not tested significantly above the limit of the Threshold Test Ban Treaty since it became effective more than 10 years ago, the continuing Soviet moratorium on nuclear testing which started in August 1985, a recent offer by the Soviet Union to permit U.S. seismic monitoring equipment to be operated near their main test site in Central Asia, and statements that our Government will not continue to abide by the SALT II agreement.

Today I would like to examine the following topics: recent scientific and technical advances in monitoring Soviet nuclear testing, Soviet compliance with the Threshold Test Ban Treaty (TTBT), a re-examination of estimates of the sizes of Soviet strategic nuclear weapons, major constraints on Soviet development of new weapons of high yield by the Threshold Treaty and the major disadvantages to our security interests if the Soviet Union is no longer constrained by the limitations of SALT II and the Threshold Test Ban Treaty.

Seismology, my main field of expertise, provides the main tools for the verification of a Comprehensive Test Ban Treaty (CTBT), for ascertaining if the Soviet Union has complied with the 150 kiloton limitation set by the Threshold Treaty, and for making accurate estimates of the yields of Soviet atomic tests. I was a member of the U.S. delegation that negotiated the Threshold Test Ban Treaty with the U.S.S.R. in 1974. I have been a member of several government panels that have examined questions of verification of atomic testing. I am a member of a scientific panel for the Department of Defense that examines methodology for estimating the yields of Soviet explosions. I am a member of the U.S. National Academy of Sciences and the American Academy of Arts and Sciences.

MAJOR CONCLUSIONS

Let me first give you a statement of the major points I wish to make today:

- 1) There is now near scientific unanimity on the methodology of estimating the sizes or yields of Soviet underground weapons tests. When this methodology is employed, it is evident that the U.S.S.R. has not violated the 150 kiloton limit of the Threshold Treaty. Both the U.S.S.R. and the United States have tested repeatedly near the limit of that treaty since it became effective in 1976.
- 2) It is in our national interest that the Soviets not test very large nuclear weapons and thence emplace either more or higher yield weapons of lighter-weight on their large intercontinental

missiles. The United States has a considerable advantage over the U.S.S.R. in light-weight weapons of high yield. SALT II and the Threshold Treaty have constrained the number of intercontinental missiles deployed by the U.S.S.R. and the weights, yields and numbers of the nuclear weapons carried by their strategic systems. In the absence of those restraints, the Soviet Union would likely have an asymmetrical advantage in that they could conduct very large underground tests easier and sooner than the United States and deploy weapons of either greater yield or greater numbers on their large missiles. A major goal of United States foreign policy should be to prevent this from happening.

- 3) Both the Threshold Treaty and Peaceful Nuclear Explosions Treaty (PNET) can be verified with high confidence. Ratification by the Senate of both of those treaties would constrain the Soviet Union by treaty from conducting nuclear weapons tests of high yield.
- 4) A Comprehensive Test Ban Treaty is verifiable with high confidence down to explosions of very small size. I and a number of my colleagues conclude that reliable identification can be obtained down to explosions of about 1 kiloton with a combination of seismic listening posts within the Soviet Union and other national technical means such as satellite photography. Recent advances in seismological methods such as the use of high-frequency waves, the greater variety of methods that can now be used to characterize seismic sources and the use of digital data ensure that a Comprehensive Test Ban Treaty will be even easier to monitor than was thought only a few years ago.

- 5) A Comprehensive Treaty or a Low-Yield Threshold Treaty would dramatically curtail the testing and development of the so-called third generation of new atomic weapons, including the x-ray laser for the Strategic Defense Initiative, which will use a nuclear explosion as its source of energy.
- 6) The main impediments to a Comprehensive Treaty or a Low-Yield Threshold Treaty are, in fact, neither scientific nor technical but rest on the assumption that the security of the United States is best enhanced by the continued testing and development of new atomic weapons into the indefinite future.
- 7) Verification of an eventual Comprehensive or a Low-Yield Threshold treaty will require a determined and vigorous monitoring effort by the United States.

RECENT SCIENTIFIC ADVANCES IN THE VERIFICATION OF NUCLEAR TESTING

More Accurate Estimates of Yields of U.S.S.R. Explosions

A great deal of work has been completed in the last few years that bears upon the correct methodology for estimating yields of Soviet explosions. Yields of explosions at the main Central Asian test site of the U.S.S.R. have now been calibrated using: 1) seismic surface waves, 2) a high-frequency seismic surface wave called Lg, 3) a Soviet peaceful explosion at that test site that produced a crater of known size (for which the Soviets have also released the yield), 4) estimates of seismic attenuation of P waves beneath the Central Asian and Nevada test sites using the fall-off of the spectrum of seismic

waves, 5) a calibration using seismic stations in areas known to be similar geophysically to the Central Asian test site, and 6) more indirect estimates based on the known speed of seismic waves and other known geophysical parameters of the Central Asian and other test sites. In addition, it is now possible to remove from surface waves a contaminating effect called tectonic release such that surface waves can now be used for accurate estimates of yield.

Each of the above methods indicates that the Central Asian test site can be calibrated in terms of yield quite accurately. The Defense Advanced Research Projects Agency and the Air Force Technical Applications Center have had committees of seismologists advise them on these matters for many years. Panels of both agencies have submitted classified reports on yield estimations for Soviet explosions and have made specific recommendations on methodology and calibrations. I understand that those reports and a more recent one by a panel of the Defense Intelligence Agency have now been made available to the Congress.

Recent Advances in Identifying Very Small Underground Nuclear Tests

The United States has conducted an extensive program to improve the detection and identification of nuclear tests since 1959. We have spent about half billion dollars in this endeavor; more than a billion dollars has been spent worldwide. Seismic methods for identifying underground testing have improved greatly during that period as a result not only funds specifically for test ban work but also a result of the more than three to four billion dollars that has been spent

annually by the petroleum and mineral industries and by various government agencies on acquiring seismic data and improving seismic methods.

I would now like to briefly describe several of the major advances in verification that have occurred since the Senate Foreign Relations Committee held its last hearing in 1977 on test ban issues. These topics include high-frequency seismic waves, sophisticated seismic techniques that utilize large portions (that is most of the "wiggles") of a seismogram to permit the identification of an event as either an underground explosion or earthquake, the utilization of digital data and the operation of a prototype verification network with data transmitted by satellite in nearly real time. I gave fairly extensive testimony on May 8 and November 20, 1985 before two House committees. I refer you to those hearing records for a more complete discussion of high-frequency and other verification technologies.

In the last few years it has been recognized that high-frequency seismic waves propagate readily across large parts of the Soviet Union. This represents an important advance in our capability to verify a CTBT. A great deal of seismological data have been obtained in Europe and Asia, including large parts of the Soviet Union, for studies of crust of the earth and for exploration for petroleum and minerals. Those data are very good for frequencies from about 1 to about 10 Hertz (cycles per second). In addition, high-frequency data have been analyzed for several of the seismic arrays operated by the United Kingdom and from several of the sophisticated stations operated by the Department of Energy as a test of instruments that could be deployed in the Soviet Union under a test ban treaty. Those data

generally indicate good propagation of high-frequency waves from small explosions in continental areas of older geology. A high percentage of the U.S.S.R. consists of older geological terrains.

Extensive data from small explosions and earthquakes in several parts of the Soviet Union have been collected by the Norwegian Seismic Array (NORSAR) and by a new high-frequency array in that country. Soviet underground explosions with yields of only a fraction of a kiloton have been detected reliably at distances as large as 2600 miles by that new array. U.S. seismic listening posts within the U.S.S.R., as agreed to in the test ban negotiations from 1977 to 1980, if they are equipped for high-frequency capability, would allow greater areas of the Soviet Union to be monitored and at closer distances.

High-frequency seismic waves offer not only the possibility of detecting very small underground explosions that would not have been detected by standard techniques but also the opportunity to combat attempts to evade or cheat on a Comprehensive Treaty. High-frequency waves will help to reduce the two cheating possibilities that worry us the most: the so-called Hide-in-Earthquake and Big-Hole scenarios.

The Hide-in-Earthquake idea involves the detonation of a small underground explosion soon after the occurrence of a large earthquake such that its signals will be masked or obscured by those of the larger event. I believe that high-frequency seismic monitoring will effectively eliminate the possibility that the Hide-in-Earthquake scenario could be used for clandestine testing. Figure 1 shows a dramatic example of the use of this technique. The upper seismogram shows a recording in Norway with conventional low frequencies. It and

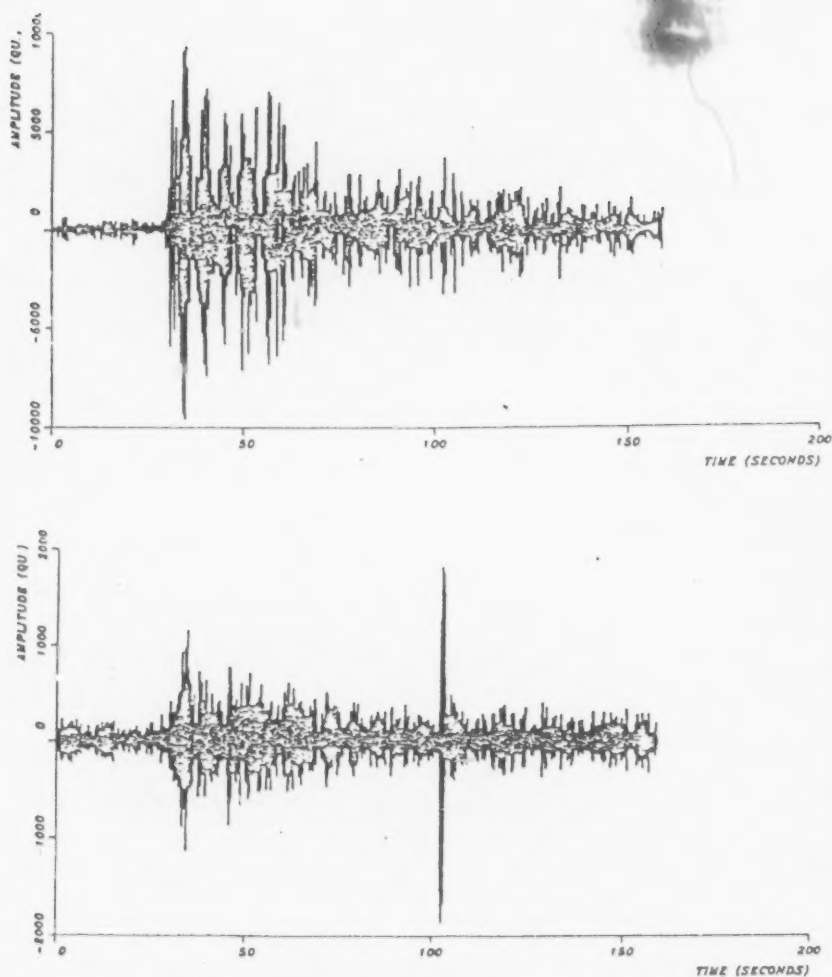


Figure 1. Example of recordings made by Norwegian seismic array of a large earthquake that arrives at a time of 30 seconds followed by a very small underground nuclear explosion at eastern Kazakhstan test site of U.S.S.R. Upper record is made with standard band of frequencies between 1.2 and 3.2 Hz. Lower trace, which clearly shows large high-frequency signal from small underground explosion, is made with a passband of 3.2 to 5.2 Hz.

the lower figure show the arrival of waves from a large earthquake in the eastern part of the Soviet Union at 30 seconds on the horizontal axis. The lower recording utilizes higher-frequency waves. It shows a very large high-frequency arrival soon after 100 seconds. That second event, which is not evident on the upper record, was an explosion of less than a kiloton at the Central Asian test site of the U.S.S.R. The very small explosion produced the largest high-frequency seismic waves even though it was much smaller than the preceding earthquake. This example also demonstrates the pronounced differences in the excitation of seismic waves of various frequencies by earthquakes and explosions -- a factor that can be utilized for identifying sources as being explosions or earthquakes.

Most of those specialists who have worked on seismic verification are in agreement that the detonation of small explosions in very large underground cavities represents the most significant evasion possibility and the one that sets the lower limit to U.S. identification capabilities. High-frequency seismic waves are not reduced as much in amplitude, that is they are not muffled as much, as the lower-frequency waves that are routinely used for monitoring.

The United States denotated a very small (0.38 kiloton) underground explosion code-named STERLING in a salt dome in Mississippi in 1966 to test the decoupling theory. The seismic data collected from that experiment as well as theoretical calculations indicate that the amount of muffling is about a factor of 10 less important at higher frequencies, i.e., at 15 to 30 Hertz, compared to that at lower frequencies commonly used for monitoring.

Several federal officials who testified before the House Armed Services Committee on September 18 emphasized the potential promise of high-frequency signal detection. I believe that reality lies somewhere between the technique being merely one of interesting, but unproven, potential and one that has been fully perfected. While exciting new work is in progress on this topic, the existing results from the high-frequency array in Norway are dramatic. That array must be described as an existing capability. It alone permits monitoring of the western third of the U.S.S.R. down to a very low level such that even small decoupled explosions would be clearly detected.

During the last five years the field of seismic verification has undergone a major revolution in data recording and analysis. The use of digital data, which was pioneered by the petroleum industry for oil and gas exploration, permits seismic waves of a wider frequency range and a much greater range in sizes to be recorded reliably. The revolution in high-frequency seismic waves probably would not have been possible without digital recording. Our knowledge of the earthquake and explosion sources has advanced to the point at which various "wiggles" on a seismic record can be analyzed and matched by theoretical calculations. This has allowed us to make much more effective use of the major differences that exist in the fundamental character of earthquakes and underground explosions and to utilize those differences for positive identification of an event as either an explosion or earthquake.

For several years the U.S. Department of Energy has operated a network of seismic stations called the Regional Seismic Test Network. Those stations record seismic data in a way that insures that no

tampering with the equipment or data has occurred. The data are transmitted for rapid analysis by satellite. That network has provided not only an important test of equipment that could be used in the Soviet Union to monitor a test ban treaty but also valuable data for continued work on improved verification. The network has provided important digital data in the high-frequency range I have mentioned earlier. The Department of Energy has decided to discontinue the operation of that network. Unless the Congress intervenes, it appears that this unfortunate decision will go forward.

The Soviet Union recently agreed to allow U.S. seismologists to operate seismic monitoring equipment near their main test site in Central Asia. Such instruments could provide valuable additional information on high-frequency wave propagation. As long as the Soviet moratorium on testing continues, equipment of that type could be used to ascertain that very small tests are, in fact, not being conducted at that testing area.

Soon after the Soviet Union announced its testing moratorium, some statements were made in the United States that the U.S.S.R. had conducted a particularly large number of tests prior to that announcement. None of our data nor that provided by the National Defense Research Institute of Sweden support those contentions. The seismic arrays operated in Sweden and Norway are capable of detecting Soviet weapons tests in hard rock down to a fraction of a kiloton. We tabulate nine Soviet explosions in 1985 compared to 21 to 31 in each of the preceding seven years. In 1985 16 announced explosions were detonated in the United States (one of which a United Kingdom test in Nevada). During 1985, 9 U.S. tests (including the one U.K. test) were

announced as having yields of 20 to 150 kilotons. Our estimates indicate the Soviet Union carried out 10 tests of the same yield range in 1985.

Defense Week quoted Richard Perle "They do it [conduct nuclear tests that project radioactive materials into the atmosphere] dozens of times a year, about 40 to 50 tests a year,..." The claim that the Soviets have conducted 40 to 50 tests per year is a considerable over-exaggeration.

CAPABILITIES FOR MONITORING A COMPREHENSIVE TEST BAN TREATY

Table 1 lists my estimates of the threshold for reliable identification of Soviet underground nuclear explosions. An important point here is that U.S. seismic monitoring stations in the U.S.S.R., as was agreed to in principle when the test ban talks went into recess in 1980, would permit verification down to explosions of smaller size than would be possible solely with networks located external to the U.S.S.R. Hence, obtaining a good internal capability should be a major goal of the United States in test ban negotiations. This would permit smaller earthquakes and explosions to be identified with confidence.

Two evasion possibilities are described: detonation in low-coupling materials and explosions in large underground cavities in salt domes. In both cases the detonation in large underground cavities, the so-called Big-Hole evasion scenario, is the most limiting: 10 kilotons for an external network alone and about 1 kiloton for an internal network. Recent estimates for the later scenario by credible experts range from 1 to 5 kilotons.

TABLE 1. Thresholds in kilotons (kt) for Reliable Identification of Underground Nuclear Explosions Using Seismic Networks External and Internal to U.S.S.R.

	<u>External Net Alone</u>	<u>Internal plus External Net</u>
1. Hard Rock or Below Water Table (no evasion attempts, fully coupled)	1 kt	0.1 kt
2. Detonation in Low Coupling Material: Dry, Porous Alluvium	1-2 kt*	1 kt
3. Detonation in Large Underground Cavity in Salt Dome	10 kt**	about 1 kt

* Limited by maximum thickness of unsaturated alluvium in U.S.S.R.

** Limited by maximum sizes of large underground cavities that can be constructed clandestinely and maintained without collapse.

SOVIET COMPLIANCE WITH THE THRESHOLD TEST BAN TREATY

The Threshold Test Ban Treaty (TTBT) was signed by President Nixon in 1974 and became effective in 1976. That treaty, like SALT II, has not been ratified by the Senate. Over the last few years various officials of the United States Government have stated that the Soviet Union either has violated or is likely to have violated the Threshold Treaty by testing above its 150 kiloton limit. On April 2, 1986, the New York Times announced that the United States Government had officially revised its procedure for estimating the yields of Soviet underground atomic tests. The revisions in methodology reported in the Times are very similar to those that I advocated in testimony before two House committees on May 8 and November 20, 1985 and that I and a number of other seismologists have advocated for 10 to 15 years. The change in methodology reported in the Times would lead to about a 30% reduction in the calculated yields of Soviet underground explosions.

The range of opinions among experts on this matter, in fact, is now not very great with the possible exception of a few officials and former officials of the Defense Advanced Research Projects Agency (DARPA). Officials and seismological experts at the Lawrence Livermore National Laboratory have expressed views about Soviet compliance with the Threshold Treaty that are almost identical to my conclusion. In testimony before the Subcommittee on Strategic and Theater Nuclear Forces of the Committee on Armed Services of the Senate on March 14, 1985, Dr. Batzel, the Director of Livermore, stated "Based on our assessment of the relationship between yields and seismic magnitudes

of the Soviet test sites and the patterns of Soviet testing, we have concluded that the Soviets appear to be observing a yield limit. A best estimate of this yield limit is consistent with TTBT compliance."

I find that statement to be very important since Livermore has a very strong group of seismologists who work on test ban verification, several of whom developed a position of yield estimation in the late 1970's before that subject became as politicized as it has become in the last several years. The former Director of the Los Alamos National Laboratory, Dr. Donald Kerr, has given more equivocal testimony on Soviet compliance on the Threshold Treaty. Nevertheless, it is well known in the seismological community that both the competence and the number of seismological experts working on yield estimation are strong for Livermore and quite poor for Los Alamos.

It is important to ask why the Government has taken so long to institute a correct methodology for estimating yields of Soviet explosions when a number of scientists who have worked in this area for more than 20 years have repeatedly stated that the United States is seriously overestimating the yields of U.S.S.R. underground tests. While recent studies have strengthened conclusions about the correct methodology, the answer was, in fact, available 15 years ago. It might be wondered if seismologists were of varying opinions about methodology or if they are to be faulted for coming up with an incorrect procedure. I must report to you that neither of those possibilities is correct. In fact, a few seismologists in DARPA and a number of other persons who are not experts on yield estimation managed to thwart attempts to arrive at a correct methodology for more than a decade.

While there is now near scientific unanimity on the correct methodology for estimating yields, several officials of the U.S. Government continue to insist that the Soviet Union is likely to have violated the Threshold Test Ban Treaty. I have attached to my testimony a letter of June 9, 1986 to Dr. Hugh DeWitt, in which Mr. M. Eimer, the Assistant Director of the U.S. Arms Control and Disarmament Agency, reiterates that view. He mentions that statements by competent seismologists brought to the attention of those in the Administration were not ignored, that spirited debate occurred during the preparation of drafts of compliance reports to the Congress, and that no policy considerations were introduced during the preparation of the analytical reports. Whether or not policy considerations, in fact, entered into their deliberations, it is clear to me that their findings are not in accord with those of most seismological experts on yield estimation. ACDA, the agency charged with the preparation of compliance reports does not have one single person on its staff who is an expert on seismic estimates of yield, the main and most accurate method of ascertaining compliance with the TTBT.

Mr. Eimer states that the Government's finding about likely violations of the Threshold Treaty is not based solely on seismological data but on the full scope of data and analyses available to the Arms Control Verification Committee. Dr. Robert Barker of ACDA stated repeatedly in hearings about House Joint Resolution 3 in 1985 that non-seismological data were also an important factor in concluding that the U.S.S.R. had likely violated the Threshold Treaty.

Dr. Ralph W. Alewine, III, Director of the Geophysical Sciences Division of DARPA, who was a member of the recent panel of the Defense

Intelligence Agency that reviewed these matters, briefed the Committee on Seismology of the National Academy of Sciences about test ban issues at their meeting on November 4 and 5, 1985. In the draft minutes of that meeting he is quoted as stating "The Defense Intelligence Agency studied this and reported that seismology was more reliable than other methods [for the estimation of yields of U.S.S.R. tests]." Thus, the case for ignoring the seismological evidence and giving great weight to non-seismic factors seems to have vanished.

In a letter of December 16, 1985 to Representative Beverly Byron, Chairman of the Special Panel on Arms Control and Disarmament of the House Committee on Armed Services, Dr. Alewine of DARPA stated "Dr. Sykes' assertion that seismic yield estimates of Soviet underground nuclear explosions can be made with a precision of 30% is overly optimistic about many of the aspects of this problem." Nevertheless, at the above mentioned meeting of the National Academy of Sciences he also stated that there are now probably three ways for calculating yield and this can reduce the error of yield determinations by about a factor of 1.73. It is now widely acknowledged that yields of Soviet explosions can, in fact, be calculated from three different types of seismic waves: 1) short-period P waves, 2) long-period surface waves (which are not nearly as sensitive to local variations in geological properties as P waves) and 3) a short-period seismic surface wave called Lg.

The U.S. Government has argued that the accuracy of yield determinations for U.S.S.R. weapons tests is poor enough that on-site monitoring of the main Soviet test site in Central Asia by U.S. equipment is required to ensure verification of the Threshold Treaty. That view

could only be sustained, however, as long as it could be maintained that uncertainties in yield estimation were about a factor of 2 or so. Alewine's statement that the uncertainty can be reduced by a factor of about 1.73 leads to even better accuracy than I have indicated. Throughout the long course of debates about yields of Soviet tests, I have heard no statements that an accuracy better than 30% would be required to verify the Threshold Treaty.

During the House Committee on Foreign Affairs hearing on House Joint Resolution 3 on May 8, Dr. Kerr of Los Alamos was asked "assuming just for the purposes of discussion that Dr. Sykes is correct in saying that there is 30-percent variance here, do you believe that a test at 195 kilotons in comparison to a test of a device with a yield of 150 kilotons would give the Soviet Union any potentially military significant advantages which we would not have if we would yield to the treaty and didn't test over 150 kilotons....". Dr. Kerr answered "Fortunately I don't have to deal with the 'if so' because I don't think the difference between 195 and 150 would be militarily significant. The sort of thing I think would be, is if the Soviet Union, for example, could test at a level like 300 kilotons."

Thus, while additional verification data may well be useful, the accuracy of present yield estimates is much better than the factor of 2 or greater that Dr. Kerr states would be an explosion of military significance in excess of 150 kilotons.

I have used surface waves and P waves to make independent estimates of the yields of the eight largest Soviet explosions detonated since the Threshold Treaty took effect in 1976. A given seismological estimate always has a certain uncertainty associated with it, the 30%

figure I mentioned earlier. Thus, if the U.S.S.R. were to test eight explosions of the same size, we would expect some of the calculated numbers by a given technique to be above the actual yield and some to be below it. For a few U.S.S.R. tests, the yields that I calculated from P waves alone are slightly larger than 150 kilotons. However, the yield estimates from surface waves for those explosions are somewhat smaller than 150 kilotons. Thus, when results from these two methods are averaged, the calculated yields are, in fact, very close to 150 kilotons. Methodology now exists for calculating yields of U.S.S.R. tests from surface waves as well as from body waves.

Hence, with the recognition that the U.S.S.R. has not tested weapons significantly above the 150-kiloton limit of the Threshold Treaty and that yields can be determined with an accuracy much better than a factor of 2, there do not appear to be any verification requirements that would preclude ratification the Threshold Treaty by the Senate.

DISADVANTAGES TO U.S. SECURITY INTERESTS IF THE THRESHOLD TEST BAN TREATY AND SALT II DO NOT CONTINUE IN FORCE

In examining Soviet compliance with the Threshold Treaty we discovered that Soviet practice is to test repeatedly weapons of a few specific sizes. We have re-examined the yields of the largest weapons tested underground by the U.S.S.R. using the same rationale mentioned in the New York Times article of April 2. The time period 1970 to the start of the TTBT is crucial since nuclear weapons of high yield probably were being tested, which were deployed in the late 1970s on

various versions of large Soviet land-based missiles, the SS-17, 18 and 19.

Figure 2 shows a histogram of sizes of the largest Soviet explosions tested from 1973 to 1976 at their Arctic test site. There are a number of prominent peaks in the histogram, of which 500 kilotons is the largest. We obtained very consistent estimates of yields by using two quite different types of seismic waves. We deduced that 500 kilotons is the yield of the weapon or weapons that were emplaced on MIRVed versions of those intercontinental missiles. Our estimates are among the lowest that have been published or given in congressional testimony for those systems.

One aspect of the downward revision in calculated yields that was reported in the New York Times on April 2 is that the yields of those large Soviet explosions at their Arctic test site prior to 1976 have been overestimated. Those overestimations have been used to portray the U.S.S.R. as having more powerful weapons than the United States. Another result that comes out of this re-analysis is that the nuclear weapons on those Soviet systems have a lower yield-to-weight ratio compared to those of comparable American systems that were deployed about the same time, that is Soviet weapons are heavier and not as technically advanced. The same thing appears to be true for Soviet Submarine Launched Ballistic Missiles with multiple warheads.

It should be realized that the Threshold Treaty has had an important constraint on the Soviet development of large nuclear weapons. A pronounced minimum in Soviet testing can be seen in Figure 2 for explosions of yields between 150 and 500 kilotons. Thus, it seems clear that prior to at least 1976 the U.S.S.R. did not develop nuclear

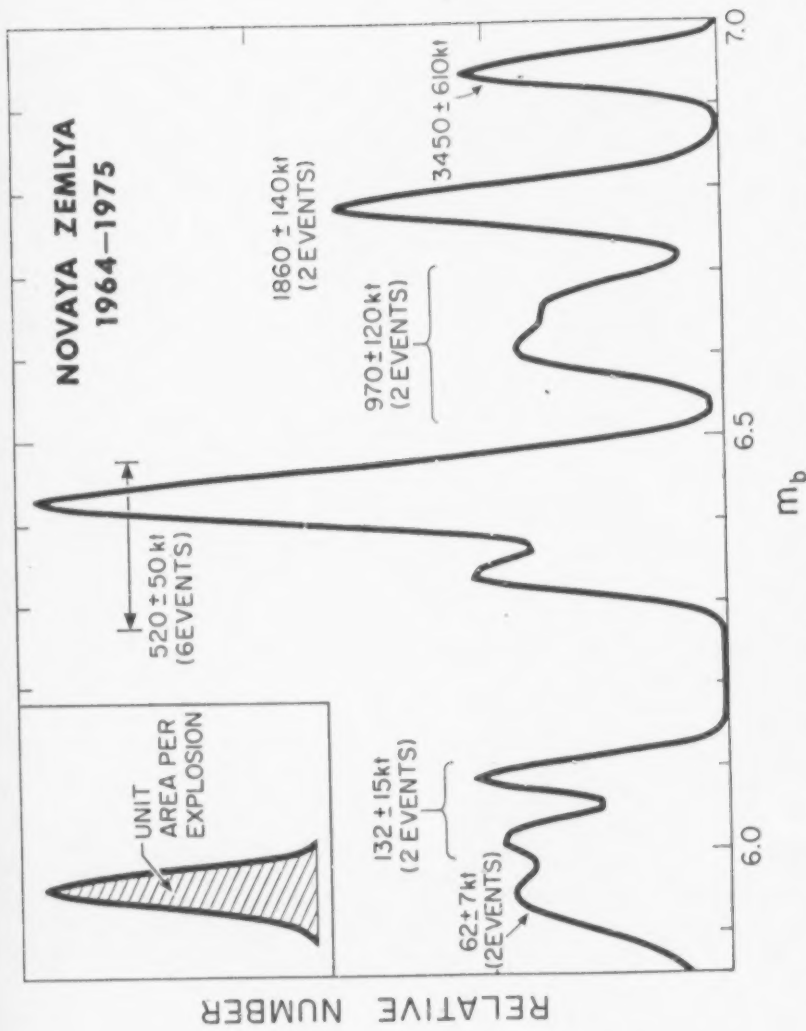


Figure 2. Histogram of number of underground explosions at Arctic test site of Soviet Union in Novaya Zemlya from 1964 to 1975 as a function of size (the seismic parameter m_b). Stated yields are averages of estimates made from body and surface waves. Note very prominent peak near 500 kilotons which is identified as the full-yield testing of weapons for the SS-17, 18 and 19. [From Sykes and Wiggins, *Proc. National Academy of Sciences*, volume 83, January 1986].

weapons with yields in that range. Since the fall of 1975 they have not tested weapons with yields significantly in excess of 150 kilotons. In his House testimony of May 8, 1985, Dr. Kerr stated "... it's our belief that one can reasonably safely extrapolate in yield by about a factor of two." From Dr. Kerr's testimony we can conclude that the U.S.S.R. could not have tested near 150 kilotons and developed a weapon much larger than 300 kilotons with high confidence. SALT II and Threshold Treaty have thus prevented the Soviet Union from taking full advantage of the heavier throw-weight of their large intercontinental missiles. Thus, it is certainly not in the interest of the United States to have the Soviets test lighter-weight weapons of say 500, 1000 or 2000 kilotons to full yield. SALT II has limited the number of missiles they can deploy; the Threshold Treaty has prevented them from developing lighter-weight weapons with yields much in excess of 150 kilotons.

Thus, it is our national interest that the present threshold be reduced considerably to prevent the U.S.S.R. from catching up with us in the development of new warheads, particularly those of lighter weight.

RECOMMENDATIONS

1. I urge ratification of the Threshold Test Ban Treaty and the Peaceful Nuclear Explosion Treaty. Both are verifiable with sufficient accuracy.
2. Every effort should be made to prevent the U.S.S.R. from deploying additional large nuclear weapons or equipping their present

ICBMs with lighter weight weapons of higher yield. The U.S.S.R. has been seriously constrained in this area by the Threshold Treaty and by SALT II.

3. The United States can reduce the Soviet threat by concluding either a Comprehensive Test Ban Treaty, a Low-Yield Treaty with the limits set by verification capabilities or by gradually lowering the present threshold of the TTBT.
4. I urge the Senate to obtain or examine the following classified documents that bear upon U.S.S.R. compliance with the Threshold Treaty and on the methodology for estimating yields of Soviet explosions: reports by panels of the Defense Advanced Research Projects Agency, the Air Force Technical Application Center, and the Defense Intelligence Agency; recent testimony to the House Permanent Select Committee on Intelligence by Dr. Paul Richards, a colleague of mine at Columbia University, and Dr. Ralph Alewine of DARPA; and the memo of April 15, 1985 from Richard Perle to General Pfautz, which has been described in the recent TV program "Perle and the Scientists".
5. Congress should seek an independent review of verification capabilities to monitor a full test ban and of opposing technical views about the need to test existing nuclear weapons in the stockpile. I suggest that such a review be conducted by the Office of Technology Assessment or the National Academy of Sciences.
6. It is not clear that any agency of the federal government has the responsibility for coming up with or reviewing improved methodologies for yield estimation. We need to make sure that

the best technical advice is used and that the process is not thwarted by agencies that do not want to see such a procedure work or who wish to see the U.S.S.R. portrayed as having larger weapons than in fact they do have.

7. There is an urgent need to make sure that the Regional Seismic Test Network of the Department of Energy continues to be operated.
8. No federal agency has the lead responsibility to provide an answer to the question how well can seismic monitoring identify small underground weapons tests? The Arms Control and Disarmament Agency (ACDA) is specifically charged with having the capacity to provide the essential scientific and technical information upon which realistic arms control and disarmament policy must be based. The Arms Control and Disarmament Act specifically mentions detection and monitoring of nuclear tests. ACDA's budget in this area, however, is a tiny fraction of a percent of that of DoD and DoE. ACDA, for example, does not have a single expert on seismological determinations of yields. DARPA appears to dominate many areas where responsibility should at least be shared. Now is the time for the United States to come up with a coherent, workable and intelligent procedure for monitoring a Comprehensive Test Ban Treaty or a Low-Yield Test Ban Treaty. This will not happen unless there is a critical review of U.S. efforts and a clear redefinition of agency responsibilities.
9. The Center for Seismic Studies, which is operated by DARPA, was originally conceived to be the U.S. center for handling unclassified data obtained from around the world under a Comprehensive

Test Ban. Many seismologists are dissatisfied with its present operation. The technology now exists for collecting digital data on a worldwide basis and transmitting it very rapidly via satellite. We need to encourage that development and to make sure that the Center is in the forefront of seismic monitoring, data analysis and test ban research.



ASSISTANT DIRECTOR

UNITED STATES ARMS CONTROL AND DISARMAMENT AGENCY

June 9, 1986

Dear Mr. DeWitt:

Ambassador Adelman has asked that I respond to your May 22, 1986 letter commenting on the discussion and debate at Stanford on May 15.

* * *

In three Reports to the Congress, which were mandated by law, the President stated that the US Government found that the Soviet nuclear testing activities for a number of tests constitute a likely violation of legal obligation under the Threshold Test Ban Treaty of 1974.

No statements by competent seismologists brought to the attention of those within the Administration responsible for the preparation of the analytical reports that are the foundation of the President's findings on Soviet noncompliance were ignored. No policy considerations were introduced during the preparation of the analytical reports and no one with access to the classified reports has so charged publicly or privately.

As co-chairman of the Arms Control Verification Committee (ACVC) Analysis Group (the NSC committee charged by Presidential Directive with responsibility for analysis of compliance issues), I directed the analysis and the preparation of the draft study on TTBT compliance.

For the initial Report to the Congress in 1984, DOE was assigned responsibility for the first draft. Technical representatives of all appropriate agencies participated in the spirited debates that occurred during the preparation of drafts, or if they so chose, commented on the drafts during the clearance process. The Working Group's final draft was discussed and endorsed in a meeting chaired by the President's Assistant for National Security Affairs with ACVC principals and other officials above the level of Assistant Secretary in attendance.

Mr. Hugh E. DeWitt
Lawrence Livermore National Laboratory
University of California
PO Box 808
Livermore, California 94550

While there were some differences among agencies on how the proposed findings should be worded, the contents of the analysis represented a consensus. That consensus report was considered at a meeting of the National Security Council chaired by the President and, subsequently, a finding was issued by Presidential Directive (NSDD).

* * *

With regard to the charge of distortion, let me simply say that you are wrong and that you do the ACVC Working Group, the ACVC principals, the NSC, and the President a disservice with such an unfounded charge.

With regard to your second charge that important seismological opinions were disregarded or improperly discounted, I do not know of any substantiated view that came before the Committee or its Working Group that was not properly considered.

* * *

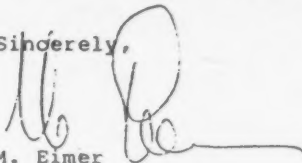
It was evident during the entire process of analysis that no single class of data available to the US could definitively settle the question of Soviet compliance/noncompliance. The central value yield, coupled with a range of uncertainty, was one of the classes of data carefully considered. In considering what weight should be given to yield estimates based on seismological measurements, the Working Group availed itself of the full spectrum of published documents and consulted with those they considered appropriate. However, the analytical components of the report forwarded to the President and, in its SECRET version, to the Congress is the product of the ACVC and entirely the responsibility of that Committee.

It is clear from your note that you believe that the findings were not based on sound analysis because the work was distorted by "policy" consideration and personal biases and because there is a body of opinion that disagrees with the findings. That body of opinion, which you apparently rely on, holds that neither a finding of compliance nor noncompliance is justified by the data (seismological data?).

One of the most fundamental precepts of analysis is that conclusions should be consistent with all the evidence. Those who claim that seismically determined yields, with all their uncertainties, should be the sole basis of assessing Soviet compliance/noncompliance with the TTBT violate that most fundamental of scientific principles.

The President's finding that it is likely that the Soviets violated that TTBT was not based solely on seismologically determined central value yields but on the full scope of data and analyses available to the ACVC. No data or analyses have come to that Committee's attention which would suggest weakening the President's findings.

Sincerely,


M. Elmer

PREPARED STATEMENT OF RICHARD L. WAGNER, JR.

The factors have changed which made nuclear testing limitations an important agenda in the 1950s and early 1960s. The current debate about test bans is really a debate about broader national security policy, and should be treated as such.

During the first ten years of the nuclear weapons era, what could be done or not done in nuclear warhead design was a major factor in determining national defense policy. Many of the most important national defense policy decisions were largely concerned with nuclear warhead development and effects issues, and hence with nuclear testing. The decisions during the Manhattan Project, the decisions to develop the hydrogen bomb and, during the 1950s, to develop relatively small ICBMs and SLBMs based on projected capabilities to miniaturize warheads, which required nuclear testing, are examples of how nuclear weapons development and testing were central to shaping national defense policy.

But since about 1960, and certainly for the past twenty years, the nature of nuclear warhead development and testing, and the relation between them and defense policy, have been very different. Warhead development has derived from and conformed to elements of national security policy developed mainly on considerations not immediately related to nuclear warhead design, (such as crisis stability, what constitutes adequate deterrence, and so forth), rather than design driving policy.

Because there has been this reversed relationship for over twenty years, the real, underlying issues in most of the current debate about test bans have to do with the more fundamental defense policies and practices related to deterrence developed over the tenures of many administrations, which warhead development and nuclear testing have served. To treat test bans separately from the more fundamental issues of national security policy obscures the real issues related to test bans. Further, treating test limitations as a separate agenda allows use of testing limitations to achieve -- by the back door, so to speak -- other arms control agendas that should be addressed fully in their own right. Stopping or slowing the pace of weapon systems modernization, for example, which is an objective whose merits and demerits can at least be debated in terms of national

¹ Recent examples of what appear to be situations in which warhead design determined policy, such as the development of enhanced radiation warheads (the "neutron bomb",) have been rare, and in that case, the development was intended to conform with and advance already established policies on collateral damage limitation and flexible response for nuclear weapons in NATO. Also, the ERW episode was blown far out of proportion; it was a detail in a relatively low priority development.

security and arms control, should be addressed explicitly rather than approaching it backhandedly by a Comprehensive Test Ban. A test ban would slow some aspects of system modernization, but this might be compensated for by other methods, with a perhaps undesirable net effect.

Let me illustrate with another more specific example. An argument made by some who favor a CTB is that, just because weapon reliability would decline without testing, we and the Soviets would gradually come to rely less on nuclear weapons. This is really an argument about whether we should continue to rely on deterrence, not an argument about testing; nevertheless, let us pursue it. Among many other assumptions, it assumes that the reductions in reliability would be symmetric. Would they be? The best answer is that we simply do not know. We do not know how rapidly either our reliability or the Soviets' would decline. If we are forced to guess -- and this line of argument does force us to guess -- the peripheral evidence we have indicates that U.S. reliability is likely to degrade faster.

Another central assumption behind this line of reasoning is that the Soviets also would like to see such a reduced reliance on nuclear weapons as would be brought about by a symmetrical degradation of reliability. It seems more likely that they would prefer to see the asymmetric degradation in reliability which would be our best guess -- in fact, they might have taken steps to make the asymmetry likely. However, if we grant, for the moment, the assumption that the Soviets would be happy to see a symmetric reduction in the two sides' reliance on nuclear weapons, certainly there are more direct ways of achieving this -- i.e., by negotiating limitations on deployments -- rather than depending on uncertain assumptions about future uncertainties.

In fact, the Soviets might well be happy to see nuclear weapons play a much reduced role. Linked with attempts to reduce U.S. influence in Europe, and Soviet conventional force and geographic advantages, such a future might be much to their liking. But if this were to happen, conventional war between the superpowers could become more likely, and who can doubt that conventional war would be accompanied by re-development of very reliable nuclear weapons on both sides, while at war -- a terrible prospect.

This leads to the observation that reducing reliance on nuclear weapons can be carried to the limits desired by those who make this argument only on condition that the U.S. and the Soviets compose our political differences so as to reduce the likelihood of conventional war, and the possible accompanying concurrent re-development of nuclear weapons. I do not know how this whole line of argument would play out, but this is the realm in which the debate really lies.

Your deliberations, then, on test bans should properly be concerned mainly with the broader policies related to nuclear deterrence, and with how these policies and test bans relate to other arms control limitations. Later, to help provide a data base for such deliberations, I will outline how warhead development and testing have related to and derived from the evolution of deterrence policy and practice. Before doing so, however, let me outline how the treatment of test bans as a separate agenda came about.

Pursuing nuclear test limitations as a separate arms control agenda is due to circumstances peculiar to the 1950s and early 1960s.

Treating nuclear test limitations as a separate agenda, rather than being explicitly linked to, and perhaps carefully phased with, progress in other areas of arms control, has an illuminating history. It is ironic that this decoupling came at about the same time (late 1950s and early 1960s) that nuclear weapon development per se ceased being a major driver of basic national defense policies and became instead responsive to policies established largely on grounds other than nuclear warhead design possibilities. In a sense, the decoupling may have been natural considering the dominant importance of nuclear testing only a few years earlier. But the detailed history shows other factors playing as well.

In the 1950s the linkage between nuclear testing limits and other limitations on nuclear arms was explicit. The consensus in the U.S. and among our allies was that limits on deployment and production were much more important than, and should precede, limits on nuclear testing. For example, John Foster Dulles opened the Geneva Foreign Ministers' Conference on November 11, 1955, with this offer: "If agreement can be reached to eliminate or limit nuclear weapons under proper safeguards, the United States would be prepared to agree to corresponding restrictions on the testing of such weapons." At the time, this was regarded as a rejection of the Soviet proposal, of the preceding May, to limit testing only. The United States was declaring that it would restrict tests only after the elimination or limitation of nuclear weapons had been achieved.

Uncoupling the two, and placing testing limits first on the agenda, was originated and first promoted by the Soviets in the early 1950s. The fact that the U.S. eventually went along, and that the nuclear testing moratorium of 1958-1961 occurred a decade before any progress in other nuclear arms limitations, was due much more to concern for the health and environmental effects of fallout from atmospheric tests, than to belief that testing limitations effectively limited the threat of nuclear war. Attention was focused even more narrowly on testing itself in 1961 by the Soviet breakout from the moratorium, with the large

Soviet and U.S. atmospheric test series which followed. This narrowing focus continued with the LTBT in 1963. The tendency to pursue nuclear test limitation as a separate agenda, which originated for these reasons peculiar to the late 1950s and early 1960s, has continued until the last few years, when the Reagan administration has explicitly re-linked testing limitation to progress in other arms control. However, we still suffer from the mistake of thinking of them separately, and from not having thought carefully, for too long, about the nature of the linkage. In this sense, as well as others, we are not ready for further test limitations.

Before leaving the relationship between nuclear testing limitations and other types of arms control, two more things should be considered: 1) The evolution to date in testing limitations relative to progress in other arms control and 2) What might we expect to be the role of nuclear warhead development and nuclear testing in the future, as other areas of arms control progress, as we hope they will?.

Limitations on nuclear testing already far exceed limits placed on deployments, production, destabilizing weapon systems characteristics, or other types of testing.

All nuclear tests are conducted underground; there are no adverse health or environmental effects. The 150 kt limit of the Threshold Test Ban constrains test yields to about one one-hundredth of the yields of large atmospheric tests and about one twentieth of the highest underground test yields. Though not limited by treaty, the annual number of tests is much less than it has been in the past -- about half to a third the annual number conducted during periods in the late 1960s. Because of the LTBT, development of our understanding of nuclear weapon effects -- which I will discuss later -- is significantly constrained. And, for the U.S., the level of resources available to the overall nuclear warhead development and weapon effects programs, of which testing is a part, is about two-thirds what it was during the 1960s.

There will be requirements for systems modernization during future arms control regimes.

Making the military and strategic relationship between the United States and the Soviet Union a much safer one will be a decades-long process. Deep cuts in the number of nuclear weapons on both sides will be an important part of the process, but it would be a mistake to think that future stability can be measured by merely counting the number of weapons that remain, or by the kinds of limits that one can hope to negotiate regarding destabilizing force characteristics. The characteristics of the remaining weapons systems and their associated control systems will be critically important in ensuring that, as reduction in numbers moves the strategic relationship into new regimes, the

essential features of crisis stability will be maintained. Adapting weapons system characteristics to new requirements of deterrence and stability will depend on continuing to develop the technologies involved. A CTB, even if verifiable and mutually complied with, would prevent us from making adjustments to system characteristics which will inevitably be needed to complement the hoped-for reductions in numbers. Inappropriate applications of military technology can be avoided by sound decision-making by the Executive Branch and Congress; freezing technology would require us to forego stabilizing modifications.

The development of warhead design technology, understanding of weapon effects, and the associated underground nuclear testing, are of course among these necessary technologies. As I will illustrate below, a large part of nuclear explosive development and weapons effects testing has been devoted directly or indirectly to helping make weapon systems less vulnerable, safer, more secure, and more controllable -- all of which will be important in arms control regimes of the future.

How nuclear weapon testing relates to national security objectives.

I have pointed out that, in contrast to the period before about 1963, the developments supported by nuclear testing (and the testing itself, of course) have derived from established national security policies and objectives, which have themselves been developed from considerations of which nuclear warhead and effects technology is only one of many. I have also pointed out that test ban debates are almost always, though usually only implicitly, really about the merits of those broader objectives and policies, rather than about weapon development itself. The confusion resulting from this obstruction of the real agenda and priorities results in poor thinking about test limitations and the role they have in arms control. To help clarify the matter, let me give here a brief description of the evolution of those broader objectives and policies which relate to nuclear weapons, and how nuclear warhead development, weapon effects research, and the related testing, have supported them. I will try to do this in terms intended to best illustrate the relationship, rather than going to the lengths necessary to give a rigorous, thorough description of the policies and objectives themselves.

Many of the national security objectives to which warhead and systems development have conformed are stated in Presidential level documents -- NSDDs and their predecessor directives -- and in various derivative DOD guidance and policy documents. These principally have to do with the military/deterrence aspects of policy. There is another category of policy -- nuclear weapon safety and security criteria -- which derive somewhat separately from the Atomic Energy Act, from early AEC policy as it has evolved in the DOE, and from corollary DOD policies. These safety and security policies are not formally portrayed as

relating to national security per se, but they are the foundation of our ability to have nuclear weapons. I will discuss them first.

Safety has been a paramount concern since the Manhattan project, with emphasis first on precluding accidental nuclear explosion and later, as that problem came to be well understood, toward preventing lower levels of potential hazard such as dispersal of radioactive material in accidents and minimizing radiation exposure to personnel handling weapons. Testing has been indispensable for these improvements in safety. More recently, many improvements in nuclear weapon security and control have been provided for by nuclear testing. This has been particularly important during the last decade with the growth of terrorism. A substantial fraction of the nuclear tests during the past several years, and currently, are devoted to these objectives.

The important thing here though, in considering further test limitations, is that nuclear weapon safety can never be good enough. This assertion, which is currently only partially and implicitly a policy position, is really a reflection of an inescapable reality in the "culture" that provides for safety. Safety is accomplished by the unflagging vigilance of competent people throughout the whole cycle of weapon design, fabrication, handling, maintenance, transportation, and disassembly. The safety record of U.S. nuclear weapons is outstanding, which means that complacency is a serious and fundamental problem. An indispensable part of fighting complacency is to always have in place programs to make further safety improvements, so as to hold the interest of the most competent people. Safety simply cannot remain static; if improvements are not always going on, the best people will drift away, safety will become a matter of routine application of increasingly poorly understood rules, and accidents will happen. Such a regimen requires continuing to improve the safety features in the warhead designs, as well as in ancillary systems and procedures, and this, in turn, requires nuclear testing. I cannot stress too strongly the serious impact that there would eventually be on nuclear weapon safety during a CTB.

Turning to the military and deterrence aspects of policy, three long-standing, central themes relate to the nuclear weapon development and effects programs: 1) the imperative of crisis stability, 2) how is deterrence best achieved, i.e., what Soviet objectives and values are to be held at risk, and how? and 3) collateral damage reduction.

Crisis stability involves both survivability and the capability to pose flexible, controlled, limited responses to various situations. With regard to survivability, it is a central tenet of our understanding of deterrence that nuclear weapons systems must not present easy targets for enemy attack. Otherwise, they would create incentives, particularly in a crisis

situation when deterrence would be most stressed, for the enemy to capitalize on such vulnerabilities. The importance of survivability was first widely recognized in the late 1950s and early 1960s and has since then, perhaps more than any other single factor, shaped the policies and the system requirements which in turn shape the nuclear warhead and weapon effects programs. Nuclear testing contributes to survivability -- and crisis stability -- in two ways. The first is by developing warheads with characteristics which allow the systems of which they are a part to be more survivable. For example, if the warhead can be made smaller the entire delivery system can be made smaller and, therefore, rendered more difficult to locate, more easily hardened, or given longer range so that it can be located in less vulnerable places.

The other, and probably more important, way in which nuclear testing contributes to survivability is by exploring the complex effects produced on various kinds of military equipment -- missiles, silos, electronics, satellites -- by explosions of our own and enemy nuclear weapons. This data is used to insure that our systems are effective (in increasingly precisely specified ways) and that they and their basing modes do not have unanticipated or hidden flaws. Although these system-hardening and effects tests are not much discussed and represent only one or two nuclear tests per year, they are absolutely essential for survivability and thus are vital for stability and deterrence. Just as with tests for warhead development, these effects tests cannot be replaced by calculation or simulation. We continue to find surprises in effects tests which can only be eliminated by the complex iteration of test, fix, and test again.

In the late 60s and early 70s two related things which bear on crisis stability, and on the particulars of how best to deter, began to be realized and implemented at policy levels. The first was that, in a crisis, both sides are likely to be so cautious and frightened that nuclear weapon use might not start with a massive, paroxysmal exchange. Escalation might well be gradual, even if it were eventually to lead to massive exchanges, and having policies and capabilities which allowed only for massive responses might well guarantee just that, foreclosing possibilities for stopping at lower levels of violence.

The second realization was that to deter most effectively it was important to hold at risk the war-making capability of the Soviet Union -- their conventional capability as well as their nuclear forces. A part of this growing realization was that to respond to Soviet attack only by a massive retaliation against population and economic base was not a credible and thus not a deterring posture, since it would guarantee a response in kind, or a first strike with similar characteristics, against the U.S. Of course, to fully understand the merits of these realizations takes long discussion. They were elaborated and made part of policy over a space of years, and were, as they evolved, endorsed

by every administration over the past fifteen years. This resulted in program and budget decisions aimed toward providing much more flexible strategic nuclear forces, capable of limited responses against specific sets of military and military-related targets. In turn, these DOD programs determined warhead designs in terms of yields, diversity of types of warhead, use of nuclear material, sizes and weights, etc. A detailed classified discussion would show that these requirements were quite stressing on warhead design and development, requiring many tests. They also drove the weapon effects testing programs in new and difficult directions.

Part-way through this evolution the TTBT was signed, and somewhat later the U.S. began to realize that the Soviets had underway a massive program to harden, disperse, and in general make survivable, their military assets and related industry. Our responses to this development -- manifested principally in the systems under development right now -- appear not to have been seriously constrained, so far, by the TTBT limitation. But it is my personal belief that, in perhaps ten years, unless we achieve the hoped-for progress in arms control, we will realize that the TTBT has been a serious constraint. Whether the Soviets deliberately exploited this connection between the TTBT and their military hardening program can only be a matter for speculation.

The third general area of deterrence-related policy guidance has to do with reduction of collateral damage -- that is, types and amounts of damage not needed to secure deterrence. Reducing collateral damage, if deterrence were to fail, has been a part of U.S. policy for many years. It is not only a moral imperative; it has a direct relationship to deterrence as well. A deterrent posture would be less credible in a crisis situation if an adversary thought we might not retaliate because of the consequences (perhaps reflected in the nature of his counter-response) of excessive destruction. A substantial fraction of our development effort has sought to reduce the potential for collateral damage. Nuclear testing is vital to this line of development as well. Indeed, nuclear testing was an important tool which permitted us to reduce the total megatonnage of our stockpile by over three-fourths since 1960. (Total yield in the stockpile is an incomplete measure of the fruits of this substantial effort, because not all approaches to reducing collateral damage relate directly to total yield. A classified discussion would be needed to illustrate what has been done.)

To argue effectively against nuclear testing, one must argue that these policies which I have described above, and which determined the content of the nuclear testing program, are flawed. I believe that, on the whole, they have been sound.

Nuclear weapon reliability depends on nuclear testing, and it would decline at a rate we cannot predict today, without testing.

One implicit but overriding aspect of national policy which has shaped weapon development -- the need to be certain of the reliability of the warheads -- warrants elaboration. Reliability relates to both confidence in deterrence and to crisis stability, as discussed above. Because there has been some confusion about testing and reliability, I would like to explain it in some detail here.

Testing is vital for establishing and maintaining confidence in the operability and reliability of nuclear weapons, just as realistic testing is essential for aircraft, radars, or any other complicated equipment. As with other kinds of complex equipment -- radars, aircraft, etc. -- reliability for nuclear warheads is designed-in. During this phase, testing is required, including nuclear testing, to find and fix potential reliability problems before the warheads are manufactured in quantity, and before the obsolete warheads they will replace are destroyed. Further, as with other complex weapons, follow-on testing is needed after the warheads are manufactured and deployed. This is because nuclear warheads -- again, like other complex equipment -- undergo changes over time which can affect their reliability. In particular, due to the chemically active materials used in nuclear weapons, a certain amount of deterioration is inevitable. The warheads are designed so that deterioration is expected to be slow and so that some degree of deterioration will not seriously affect operation. But because they do deteriorate, and because the deterioration and potential problems are sometimes hard to predict, there is an ongoing program to search out any reliability problems in the stockpile. From time to time this careful scrutiny finds unexpected conditions that, if uncorrected, would result in development of serious reliability problems for a system. Through rigorous quality assurance inspections, and with underground nuclear testing and the knowledge derived from it, these potential problems are assessed and fixed before they become serious. While not all such potential problems require nuclear testing to find and fix, some important ones do. (Assertions to the contrary by a number of prominent physicists are simply wrong.)

Without underground nuclear testing, some potential reliability problems would go undiscovered, or if discovered, could not be corrected with confidence. In this situation, eventually most systems would develop problems, and the reliability of the stockpile would, over time, decline from its currently high levels. Perhaps as bad, we would not know what the reliability was. This would be a dangerous situation for as long as we rely on nuclear deterrence for our national security.

I would like to make another comment with regard to nuclear weapon reliability. Despite our emphasis on it, the people involved in the nuclear aspects of warhead design do not really know what "reliability" means. I do not mean to imply that these people are not competent and skilled, or that they have not done

their jobs well. Technical people, in almost all cases, understand reliability on the basis of statistical testing -- doing large numbers of tests on essentially identical items. In cases where that cannot be done -- whether it is nuclear warheads or solid rocket joint seals -- the technical person is handicapped, and develops protocols and routines that cannot be quantified to give him a measure of confidence, but he does not fully understand what reliability means in the absence of statistical testing. Endless requests to explain the matter, before Congress and elsewhere, cannot compensate for the fact that the people who design nuclear warheads cannot thoroughly articulate how they assure reliability, but instead have developed a subjective, judgment-based process that seems to work. The understanding gained from testing is essential to this process.

Dr. Carson Mark has testified before this Committee that it would have been possible to develop a stockpile of more reliable warhead designs. While there is debate on this within the expert community, I share his view; we have, to some unknowable extent compromised reliability in order to make the weapons smaller, or cheaper, or in some other way better suited to the requirements. While I believe today's stockpile is adequately reliable, about one-third of the systems that have entered stockpile have had problems discovered and/or fixed by nuclear testing.

The lesson from all of this -- the history of finding and fixing problems, and that we cannot quantify or explain what we mean by many aspects of reliability -- is that we are in a more marginal situation than we should be, a situation in which we simply do not know how rapidly reliability would decline. We have some experience with weapons 20 years old, or a little older, but we have no experience with weapons thirty or forty years old. For our "modern designs", which are different from older ones, we by definition have less reliability and aging experience, which might not be offset by the fact that they are younger. While my guess is that stockpile reliability would decline rather slowly during a CTB, we simply cannot be certain that it would not decline fairly rapidly.

Related to weapon reliability during a CTB, I think it is possible that there would be a large number of expert people who would leave nuclear weapon design work, especially among the younger people to whom we would look to maintain confidence in the stockpile in the farther future. The exodus would be only partly because it would be technically more difficult or less satisfying to do their jobs. Nuclear weapon development is controversial. The people involved rely no more and no less than Senators or businessmen on the knowledge that their work is valued by the communities -- local and national -- in which they live. The unbroken sanctioning of this work by the administrations of nine successive Presidents has been important, I believe, in the decisions of many people to enter and to stay in it. The people involved know how essential nuclear testing is to their

entire enterprise. A CTB would say to these people that their nation no longer values their work. I believe many would leave.

Some proponents of a CTB believe that this is exactly its purpose. While many people in the Congress and the nation disagree on how and how much to use nuclear weapon technology in our national defense, I hope that the U.S. Senate would agree that to rely on nuclear weapons without a competent cadre of technical people to support our posture would be profoundly unwise.

THE RELATIVE EFFECTS OF TESTING LIMITATIONS ON THE U.S. AND ON THE SOVIETS.

The Soviet Weapon Program: "ahead" or "behind" is not the right question.

A point central to the test ban argument must be the relative effects of further test limitation on the U.S. and the Soviet Union. And central to this question is the fact that we know almost nothing about the particulars of the current status of Soviet nuclear weapon designs and development. We do know that they have a very active program -- apparently considerably more active than the U.S. program in warhead development and much more active in exploring weapon effects and survivability. We know they have highly qualified people involved, who do excellent unclassified work in areas of science related to nuclear weapons. We know, from analysis of fallout collected prior to 1963, that for some kinds of designs -- the areas they needed most to explore at that time -- the designs were clever and advanced for their time. But we do not know where they stand today -- a fact that should give us pause when we consider further limitations on testing.

There are some who argue that we are "ahead" in warhead technology and should negotiate a CTB to freeze our advantage, especially to keep the Soviets from developing efficient warheads for small MIRVs. But we simply do not know whether we are "ahead" or "behind".

In any case, whether we are ahead or behind is the wrong question. The right question to ask with regard to comparing the Soviet and U.S. weapon development programs is: to what extent does the level of each nation's nuclear warhead technology adequately support each nation's national security objectives, which undoubtedly differ in general, and in detail. How much does each nation rely on nuclear warhead technology? Unlike whether we are ahead or behind, we can answer the right question with some certainty, I believe, from more general considerations. The answer, I am convinced, is that the U.S. almost certainly relies considerably more on nuclear warhead design for

achievement of our national security objectives than does the Soviet Union. Let me develop this point a little further.

The U.S. relies more on advanced warhead technology than the Soviets do.

Each nation relies on a variety of technologies to achieve its national security objectives. These include such things as missile guidance accuracy, submarine quieting, satellite surveillance, communications, and many more -- and, of course, the technology of nuclear warhead design. I believe that, among those many contributions of technology to each nation's national security objectives, the U.S. relies more on the contributions of warhead technology than does the Soviet Union. There are a number of examples which illustrate this point.

Two of the types of nuclear warhead features which can be discussed here, and which contribute to the U.S. and to the Soviet postures, are the safety, security and control of the weapons; and the yield, weight and size of the warheads.

The U.S. has standards of safety for our nuclear weapons which are almost certainly higher than those in the Soviet Union. The U.S. has, and no doubt the Soviets also have, highly effective means to preclude a nuclear explosion in any accident involving a nuclear weapon. But for us, there is a great deal more to nuclear warhead safety than this. For example, we go to great lengths in warhead design to preclude even dispersal of radioactive material in an accident. The hazard from such dispersal is far, far less than from an accidental nuclear explosion -- comparable to many hazards accepted in everyday life -- but, by the standards of our society, it is unacceptable. Similarly, we stringently limit the already low levels of radiation emitted by the warhead in normal storage, so as to ensure minimum possible radiation exposure to troops maintaining and transporting the weapons in peacetime. We devote nuclear tests to developing these features. By contrast, everything we know about safety practices in the Soviet Union, and there is a lot of evidence, says that they would simply not be concerned about these aspects of safety, and would not develop warhead design features for these reasons.

I believe there is a similar asymmetry with regard to security and control features in the warheads. The U.S. and no doubt the Soviets as well have highly effective means to prevent unauthorized launch of nuclear weapons by those who have legitimate custody of them. But partly because of the open nature of democratic societies, we go to great lengths to build features into our warheads to protect against actions of outsiders -- terrorists, psychotics, etc. In contrast, the Soviets almost certainly can rely much more on rigid controls over their populace, and on controls external to the warheads, to

protect against such threats rather than having to rely on warhead design.

There is also a striking asymmetry in the extent to which the two nations need to maximize warhead yield within the allowed size and weight constraint, or to miniaturize the warheads at a given yield. For decades the Soviet Union has had an extensive program to harden and disperse its national security assets, including not only its weapons and military forces, but its military related industries and leadership as well. We have only recently come to understand the remarkable extent of this program. In contrast, most locations in the U.S. which the Soviets might target are soft -- with the exception of Minuteman silos and a few other sites -- and their locations are well known. Since the Soviets have now achieved nearly the same delivery accuracies, and since their missile throwweight is much greater, the Soviet Union almost certainly does not need to optimize the yield-to-weight ratio of its warheads to the extent that the U.S. must -- even for the smaller warheads that are now entering their inventory.

In a classified discussion I could add other similar examples of how differences in the strategic objectives, the delivery systems, and the political and societal perspectives of the U.S. and the Soviet Union require the U.S. to rely more on advanced technology warhead designs than the Soviet Union.

One final related point is that, on the average, the warheads in the U.S. stockpile are older than those in the Soviet stockpile. The Soviets began quantity production later than the U.S., and in the last decade they have had a much more aggressive modernization program. This has offered them greater opportunity for warhead modernization than the U.S. This means that their stockpile contains warhead technology more recently developed by their design labs than does ours.

Warhead reliability is likely to decline faster for the U.S.

With regard to the reliability of Soviet warheads, I believe that both their relatively lower need to optimize for yield, some aspects of safety, and other operational characteristics, means that they may very well be less subject to reliability degradation than the U.S. would be. Dr. Carson Mark has said that we could have designed more reliability into our warheads. I agree with him, and believe that because the Soviets rely less on advanced warhead technology, they may well have done just that.²

Beyond possibly optimizing individual warhead designs more toward high reliability, there is some evidence, which we cannot go into in an open forum, that the Soviets have designed their overall program to better allow for recovery from unreliability during a CTB -- for example, one approach might be by the ability

to easily adapt a reliable warhead design from one type of delivery system to replace an unreliable warhead design in another. In many cases, for us to do this would require nuclear testing. Whether this indicates that the Soviets have deliberately shaped their program over the years to be ready for a CTB, we do not know.

In summary then, I believe that we cannot be certain that the reliability of the U.S. stockpile would not decline fairly rapidly during, say, the decade after a CTBT. The foregoing discussion makes it clear that there is a good chance -- better than 50/50, I believe -- that the Soviet stockpile reliability would decline much more slowly than the U.S. stockpile reliability.

Are there other arms control benefits which would offset the military/technical disadvantage to the U.S. of further test limitations?

On balance, then, as to the military/technical impact on the U.S. and the Soviets, there would be a net disadvantage to our national security with a CTB. We depend more on advanced technology in nuclear weapons than do the Soviets, and we are likely to need to continue to do so. We would also have to accept the likelihood of an asymmetric degradation in warhead reliability on an unpredictable time-scale. Are there other kinds of benefits from a CTB that would offset these risks? In particular: Will a CTB increase the momentum of other arms control, such as limits on deployments and destabilizing force characteristics? Will it materially reduce the prospects for nuclear weapon proliferation? Let me take these two points in turn.

I see no evidence that a CTB would somehow make it easier to reach other arms agreements with the Soviets. What can be inferred from the history of test limitations, and from what little is known about the Soviet use of the technology, is that their long-standing emphasis on nuclear test limitation as a

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Some may argue that the U.S. nuclear weapon development program should be faulted for not optimizing more toward reliability. President Carter, in 1980, when he proposed funding to revitalize the U.S. nuclear testing program, made just that point. The development program since then has moved in that direction. We now do more nuclear tests for reliability, and have found (and fixed) problems by doing so. The warhead for the Trident D-5 missile, now in development, has special requirements for reliability over the stockpile life and to increase the likelihood that it could be remanufactured, if necessary, in the future. But despite these recent measures U.S. stockpile reliability will still decline, without testing.

separate agenda has been intended largely to gain marginal advantages in the military/technical competition. With regard to lessening of tensions, slowing the rate of modernization, and so forth, if these are Soviet objectives, they would be better achieved through more direct limitations on deployments. To the extent that the Soviets will not agree to a more direct approach, we should be skeptical of the posited benefits of CTB.

The nature of nuclear proliferation has changed. Testing limitations have little or no leverage.

Two things have changed since the time when emphasis was first put on the connection between proliferation and nuclear testing by the major nuclear powers. First, the spread of nuclear weapon capability has not been as rapid as was feared twenty or even ten years ago. Second, knowledge of the basic concepts and many techniques of nuclear explosive design have, unfortunately but inevitably, become part of the worldwide technology base. With this, the role of nuclear testing for a potential proliferant has changed. Twenty years ago, nuclear testing must have been viewed by many possible proliferants as an iterative part of an extended development cycle. Today, for a simple nuclear weapon designed by a proliferant, a nuclear test may well be viewed only as a final confirmation that no mistakes have been made in the weapon design. Indeed, for several potential proliferants, a nuclear test may not be deemed necessary at all. Accordingly, the leverage on proliferation which could be exerted by test limitation treaties is now substantially reduced -- in my view to almost none. Let me elaborate on these changes.

The technical and political strategy of potential proliferants may be beginning to follow a common pattern -- that is, to pursue nuclear weapon development up to some selected point of maturity. This would perhaps be measured in how many more months or years it would take to actually produce a reliable weapon or weapons. Then the technology would be put on "hold", devoting only the level of effort needed to keep from losing the capability already developed. How close to full capability a particular nation will feel it must come will depend on the nature of its national security problems. If they are severe, it will get quite close; if the need is less, the development will be put on hold at an earlier stage. (Sweden might be an example of the less worrisome end of the range.) The nation will then adjust its program as its national security problems change. In this near-equilibrium state of suspended proliferation, the confirmatory nuclear test, if it is needed at all, is the very last step, probably to be taken only in circumstances so dire that political inhibitions due to formal nuclear testing limitations will be easily overridden by overwhelming national security concerns. (Indeed, many treaties already include "supreme national interest" escape clauses.) In fact, the nation may perceive that it is better to wait and use a confirmatory

test as a demonstration of resolve during a crisis -- a step short of actual use.

In summary, then, I see no benefits from a CTB with regard to opening up avenues to other arms control objectives, including non-proliferation, which would outweigh the net military-technical disadvantage to the U.S. Since I believe the risks of a CTB outweigh these minimal benefits in a clear-cut way, even if the Soviets were to fully comply with a CTB, the issue of the verifiability of a CTB enters my assessment only in the nature of an additional consideration. But Soviet non-compliance would clearly add to the risk. In some circumstances, only one or two evasive nuclear tests could give the Soviets substantial additional advantage, and such tests can be done with deliberate evasive techniques, well above the normal seismic identification threshold.

We need more work before test ban verification technology can be a useful part of the process of judging compliance and determining what to do about Soviet non-compliance.

Regarding test ban verification in general, some technical progress continues to be made, but it is simply not yet adequate. I am sure you will hear a great deal of technical discussion about the status of test ban verification. I would like to add to that the following. There are two serious flaws in seismic verification methods: they inherently involve probabilistic statements and, unlike verification techniques for other kinds of arms control treaties, they have never been "wrung out" and understood thoroughly by using them routinely as intelligence tools.

Scientists, who make up most of the verification technology community, are comfortable with statements of probability. Much of modern science, especially physics, is so dominated by phenomena which are irreducibly probabilistic in nature, that if a distribution of probabilities can be established -- not a certainty, but just a statement of relative probabilities -- the scientist will view the problem as solved. But this kind of "solution" is far from acceptable in the world in which national security decisions must be made based on matters of treaty compliance. This is one reason, I believe, why many in the scientific community assert that the verification problems for nuclear test limitations are essentially solved, while many national security decision makers feel that they are not.

A statement such as "at the 90 percent confidence level, there is a 75 percent probability that some one or more of the Soviet tests during the past ten years has exceeded the 150 kt threshold" is simply not very useful. Statements about the probable yield of any single test are even less useful. One can

perhaps draw conclusions from such statements about Soviet compliance as a matter of political principle, but it is almost impossible to determine what U.S. responses should be as determined by the national security implications of Soviet non-compliance.

Some might argue that this probabilistic nature of seismic techniques is not an insurmountable problem -- that techniques exist for reducing the statistical uncertainties to a low enough level that seismic verification takes on the nature of other arms-control treaty monitoring methods -- satellite photography, telemetry intercept, etc. That may be so, but there is another problem: the technical measurements are part of a process that goes beyond them, and that process should be demonstrated in the same way that we have demonstrated and understood the process of using satellite photography or telemetry intercepts as monitoring techniques. This includes the fact that we were using those techniques as inputs to national security decisions long before they were used for treaty monitoring, and the experience base was there. The same cannot yet be said for any seismic monitoring method. We need more experience with better monitoring techniques before we ratify or negotiate any further test limitations.

Further partial limitations are similarly undesirable.

Finally, let me turn to the subject of possible further partial limitations -- lower yield thresholds and/or quotas. These are finer-scale changes than a CTB, and assessing their merits will involve looking at finer details, many of which are classified. On the whole, the net military-technical disadvantage to the U.S. would probably be less than in the case of a CTB, though there would still be a risk, but political benefits like those posited for a CTB are likewise reduced -- in relation to nuclear weapon proliferation, they are very clearly nil. The difficulty of verification and the import of Soviet non-compliance are very clearly worse, for both reduced thresholds and quotas, than the situation today with the TTBT limits.

For a reduced threshold, the fractional spread of the probabilistic yield distribution would be wider than for the current TTBT. And the military/technical leverage from non-compliance is probably greater in a reduced yield regime than around 150 kt. A larger fraction of the "technology space" would be accessed by non-compliant testing with, say, 60 kiloton tests above a 20 kiloton threshold than for 300 kiloton tests above a 150 kiloton threshold.

Also, the U.S. has built a substantial data base at yields just below the 150 kt threshold -- a data base all the more important because it pertains to performance of systems with

yields above the threshold, and so must compensate for those increased uncertainties. It will be years before we have developed enough confidence in the weapons developed since the TTBT was signed to be able to forego access to the yield regime just below 150 kt in which our data base exists.

Finally, a quota would be hard to monitor because of uncertainties in how many devices were detonated to generate an observed seismic signal. This would be further complicated by the uncertainties in yield measurement.

DR. RICHARD L. WAGNER

Dr. Wagner joined Kaman Sciences Corporation in April 1986. He is the Vice President and Executive Assistant to the President. He has direct responsibility for Kaman Sciences' East Coast operations, and also participates in the full range of management and technical activities of the company as a whole.

Dr. Wagner's career has covered virtually the entire spectrum of work related to nuclear weapons. Before joining Kaman Sciences, Dr. Wagner was appointed in August 1981, as Assistant to the Secretary of Defense (Atomic Energy) and was confirmed by the Senate as Chairman of the Military Liaison Committee in May 1982. In these capacities, he was responsible for the relations between the DOD, DOE, the Congress, and other agencies related to military applications of nuclear energy. He was responsible for planning for modernization and upgrading of the nuclear weapons stockpile, and for oversight of DOD nuclear weapons development programs and the associated infrastructure. He was also responsible for the safety, security, control, and survivability of nuclear weapons systems, and for the DOD chemical warfare and biological defense programs.

From 1963 through 1981, Dr. Wagner served in several capacities with the University of California's E.O. Lawrence Livermore National Laboratory (LLNL) in Livermore, California, focusing on nuclear weapons research and development. Early work involved research on advanced nuclear explosives, and study of the interactions between the effects produced by nuclear explosions and the operation of antiballistic missile (ABM) systems. He led development of the SPRINT ABM nuclear warhead, and did work on the SPARTAN ABM warhead.

From 1970 through 1971, he was responsible for the LLNL's "Net Technical Assessment" project sponsored by DOD and CIA, which involved assessment of Soviet programs and corresponding US programs, including analysis of intelligence on Soviet nuclear weapon programs.

From 1972 through 1975, Dr. Wagner led one of the Laboratory's two nuclear weapon design divisions. During this period, his program developed, for stockpile production, the warheads for Poseidon C-3, Lance, the 8-inch nuclear artillery projectile, and a new strategic bomb. Major development thrusts for these and more advanced systems included improved system safety and control, and improved understanding of the physics involved during the nuclear explosion.

From 1976 to 1979, Dr. Wagner served as Associate Director for Nuclear Tests, responsible for carrying out the Laboratory's underground test experiments at the Nevada Test Site. He also supervised the Laboratory's programs on treaty verification technology.

Before leaving LLNL in 1981 to join DOD, Dr. Wagner served for two years as the Laboratory's Executive Associate Director, working with and acting for the Laboratory Director in management of all the Laboratory's programs and the related administrative functions.

During his tenure at LLNL, he was also involved in work with the Department of Defense on advanced non-nuclear munitions, and with the DOE in development of capabilities for combatting terrorism involving nuclear explosives or radioactive materials. He was a member of the Defense Science Board, the Joint Strategic Target Planning Staff's Science Advisory Group, the Army Science Board, and the Defense Nuclear Agency's Science Advisory Group on Effects, and served on several other advisory committees and task forces.

Dr. Wagner is a member of the American Physical Society, and in December 1985 received the Department of Defense Distinguished Public Service Medal.

Education:

- PHD, Physics, 1963, University of Utah
- BA, 1958, Williams College, Phi Beta Kappa

Security Clearance Level: Top Secret

May 1986

AGREEMENT BETWEEN THE NATURAL RESOURCES DEFENSE COUNCIL
AND THE ACADEMY OF SCIENCES OF THE U.S.S.R.
MAY 28, 1986

From the 22nd to the 23rd of May, 1986, Soviet and U.S. scientists met in Moscow to discuss informally, a broad range of scientific problems related to the verification of a test ban treaty.

The meeting was attended by observer - scientists from Sweden and India, who reported on the technical basis for the offer by the Five Continent Peace Initiative to monitor a testing moratorium.

The participants agree that the current state of geophysical knowledge gives reasonable confidence in the detectability, using practical seismic networks, of nuclear weapons tests down to yields at, or below, one kiloton.

In order to ensure an early start of efforts to perfect seismic techniques, the Academy of Sciences, USSR and the Natural Resources Defense Council, Inc. agreed to launch, as soon as possible, a joint study of seismic events using US - manufactured high-accuracy instruments, in particular around the area of the test-site near Semipalatinsk.

Soviet experts have expressed willingness to participate in similar projects in the USA around the Nevada test-site.

The findings of this project will be helpful in demonstrating verification procedures to be used during a test moratorium or under a nuclear test ban treaty.

Under this agreement, three seismic monitoring stations shall be established adjacent to each of the principal nuclear weapons testing sites in the two countries: near Semipalatinsk in the USSR and the Nevada test-site in the US. These six stations will be manned and operated jointly by the Natural Resources Defense Coun-

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cil of USA and the Academy of Sciences of the USSR, subject to issuance of the necessary visas for travel to the locations chosen for observation points.

The equipment for all the stations will be obtained and supplied by the Natural Resources Defense Council. The equipment for the Academy will be paid for by and belong to the Academy if permitted by US regulations, and if not shall be paid for by the Natural Resources Defense Council. The equipment for the United States shall be paid for by the Natural Resources Defense Council. The installation in the USSR shall be paid by the Academy and in the US by the Natural Resources Defense Council.

Travel of US personnel to Moscow will be paid by the Natural Resources Defense Council and of USSR personnel to New York or Washington D.C. by the Academy. Incountry travel and food, housing and other expenses of personnel in each country shall be paid by the Natural Resources Defense Council in the US and by the Academy in the USSR.

On termination of the project equipment paid for by the Academy shall be retained by the Academy, otherwise shall be retained by the Natural Resources Defense Council.

Commencement of the joint project shall be, if possible, before the end of June 1986, or as soon thereafter as in practicable.

This agreement is subject to the Natural Resources Defense Council obtaining the necessary funding of its obligations, which shall be confirmed within 21 days of the signing of this agreement.

Natural Resources Defense
Council

Adrian W. Dewind
Adrian W. Dewind

Academy of Sciences of
the USSR

E.P. Velikhov
E.P. Velikhov
28.05.86

NUCLEAR TEST MONITORING PROJECT, TECHNICAL
REVIEW AND STATUS REPORT

On May 28, 1986 the Natural Resources Defense Council (NRDC) entered into an unprecedented agreement with the Soviet Academy of Sciences. The agreement calls for three seismic stations to be established around the principal U.S. and Soviet Nuclear Weapons Test sites in order to record seismic events at and in the vicinity of these test sites, with such data to be used to study a wide variety of scientific questions related to test ban or moratorium verification. The stations will be jointly manned by American and Soviet scientists and will operate for at least one year. The data from the stations will be made available to both governments and to the public. NRDC has invited the U.S. Government to become fully involved in all aspects of the project.

In July, NRDC's field team, including leading seismologists from the University of California and the University of Colorado, began installing seismic monitors around the principal Soviet test site at Semipalatinsk, near the town of Kakaralinsk. In August the second station began operation near the village of Bayanaul, northwest of the test site. In September the third station at Askaili, 70 Km southeast of the city of Semipalatinsk, began operation. All three stations are now recording valuable geologic data of the Soviet test site.

Sensitive high-frequency seismic equipment, which will be able to detect nuclear explosions as small as a few tons, is being manufactured and will be installed in 300 foot deep boreholes in both the U.S. and U.S.S.R. Preparations are underway for reciprocal seismic stations near the Nevada nuclear

test site. An anticipated September visit of Soviet seismologists to survey potential seismic monitoring stations was delayed due to certain conditions placed on their visas by the U.S. government.

This report sets forth the detailed organizational plan and schedules of the monitoring project and includes descriptions of the high-frequency seismic sensor and digital recording systems to be used. As required by the agreement, stations and operations in the U.S. and U.S.S.R. will be essentially identical, even though the time schedules for installation and operation in the two countries are somewhat different.

A scientific program is being designed to provide seismic data which has relevance to three separate areas of verification research, in particular:

- (1) Seismic verification of a time limited nuclear test moratorium.
- (2) The verification of compliance with current threshold limitations on nuclear testing, in particular compliance with the 150 kt. yield limit recognized by the U.S. and U.S.S.R.
- (3) The scientific and operational aspects of verification of a low threshold or comprehensive nuclear test ban treaty.

In addition there are several areas of basic geophysical research that can be investigated using the very high frequency data that will be obtained. Specifically:

- o Seismic source ~~radiation~~ characteristics at high frequencies and the relation of such observed characteristics to the physics of the nonlinear processes involved in the release or conversion of other forms of energy to seismic radiation.
- o The quantitative characteristics of the propagation of various types of seismic waves in continental areas, in particular the propagation of high frequency signals in crust-upper mantle wave guides.
- o The inference of the structure of the earth in the vicinity of the test sites.
- o The characteristics of high frequency noise at and near the earth's surface and inference of its physical origins and modes of propagation.

Furthermore, it is to be expected that, as data is acquired and experiments and analysis progress, there will be other scientific questions that will arise and be investigated.

There are strong inter-relationships among the three areas of verification research and also between the basic research topics that can be addressed, we discuss these relationships. However, in view of the fact that the NRDC-sponsored part of this project involves only the installation, operation and routine analysis of the data, support for research in the more basic scientific questions that can be investigated using this data must come from other sources. In this regard a NRDC-sponsored Seismic Monitoring Advisory Committee (SMAC) will serve to identify and carefully define specific projects that could be undertaken by other organizations. Indeed, it could be expected

that many of the members of such a committee would be interested in the research possibilities of the data, and would initiate funding efforts to explore some of the more basic research questions that could be pursued.

Furthermore, we anticipate similar basic research efforts by the Soviets, using these data, and would expect that a number of cooperative studies could be identified and pursued. Therefore, among the important objectives of this project there are not only those involving the installation and operation of the stations, and the routine analysis of the data obtained, but also the identification and definition of more in-depth research studies addressing both verification issues and fundamental problems and seismology and geophysics.

In order to indicate how the data to be obtained in the proposed project will be important in verification and basic research studies, we have described, in the next section II, specific scientific questions that can be addressed using the high-frequency data to be obtained. This discussion is included not only to illustrate the importance of this project for verification, but also to provide background information on the methods and problems related to seismic verification in the three verification areas previously mentioned.

In Section III we have included a fairly detailed statement of the work to be performed and a schedule for its performance. As already indicated, there are several major project tasks identified which, in general terms, are:

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- o Installation and Operation of the U.S.S.R. stations.
- o Installation and Operation of the U.S. stations.
- o Routine Data Analysis and Event Bulletin Preparation
- o Identification and Definition of Supplemental Experiments and In-Depth Research Studies.

The project personnel who have been assembled to perform these tasks are listed in Section IV, including the Principal Investigator for this proposal and those from UCSD, as the principal sub-contractor for the project. In addition, in view of the importance of supplemental research studies involving broad-based scientific participation, we have included, in Section V, a list of the NRDC advisory committee members and a description of the function of this committee.

II. Technical Review and Related Research

As noted previously, there are several verification research tasks that can be addressed if high-frequency seismic stations are located close to active nuclear test sites. In the following discussion we summarize the technical basis for the different seismic verification procedures to be followed under conditions of a moratorium, a test ban treaty or a threshold treaty and also indicate how the presently proposed test site monitoring project would contribute to a more confident application of these procedures. In what follows, we address each of the different types of testing limitation agreements separately and discuss how this project, and simple extensions of it, can impact each of them by contributing direct verification capability as well as data that can substantially reduce several technical

uncertainties.

To place this discussion in a proper context, it is useful to pose some of the more important technical questions related to verification issues and then to address them in the following discussion. In this regard, some of the relevant questions might be phrased as follows:

- o What kind of seismic monitoring and analysis can provide verification of compliance with a time limited test moratorium?
- o What seismic studies, using stations at or quite near current test sites, can be undertaken to assess the relative accuracy of various methods of explosion yield estimation, at both high and low yield levels? Further, can we "calibrate" test sites using near-in seismic data, along with teleseismic data, to provide new determinations of signal magnitude bias effects between test sites and also obtain more accurate estimates of explosion yields for past tests?
- o How many seismic stations, of what type and how distributed, are necessary to provide verification of compliance with a U.S.-U.S.S.R. low threshold test ban treaty, with a threshold set at about 1 kiloton? Is there any practical seismic network that will provide adequate monitoring capability for verification of a comprehensive (zero threshold) test ban treaty?
- o Are there sufficiently robust differences in the seismic signals generated by nuclear and chemical explosions in various possible environments (i.e. in large underground cavities or in contact with different types of media, of widely varying physical characteristics) to allow us to

identify both the explosion type and the local environment of the explosion?

- o How well do seismic event identification procedures work at low magnitude levels in terms of numbers of unidentified or misidentified events to be expected out of a large population of seismic events in the U.S. and U.S.S.R.?

These, among other related questions, have been considered, at least for the most part, in a number of past studies. However, not all the questions can be answered with the degree of confidence that we would like. Largely this is because the appropriate seismic data from both the U.S. and the U.S.S.R. has been unavailable. Specifically, to answer questions about the detectability and discrimination of small seismic events we need high-frequency (5 to 50 Hz) seismic signal and noise data, and such data has, until now, not been available. However, with the recent availability of very low internal noise, high-frequency seismic sensors and recording equipment, we are now in a position to obtain the required data. Thus, with the signing of the NRDC-Soviet Academy agreement we can now place such instrumentation near the two principal test sites in each country and not only monitor any nuclear tests at these sites, but also conduct a number of studies and supplemental experiments designed to provide more definitive and confident answers to some of the questions previously posed. While we certainly cannot claim that the NRDC-Soviet Academy project will enable us to provide final answers to all of these questions, we do, as certainly, feel that

very considerable progress can be made in this regard, particularly if we are able to expand this program to include a few more research tasks and experiments.

In the following discussion we will focus on the three major areas of verification operations mentioned earlier (i.e. verification of a moratorium, yield estimation and verification of a long term test ban treaty), and in the course of the discussion try to indicate how this project will contribute to our capabilities in these areas through more complete and confident answers to the questions just posed.

Monitoring a Time Limited Moratorium

Seismic events recorded by a multi-station network in the near regional distance range around a nuclear test site (that is within two to three hundred kilometers) can be quite accurately located using observed arrival times from several seismic signal types ("phases") at each of the several stations. This capability also improves with time as events of known location are used to calibrate the network and infer details of the earth's shallow structure within the network. Merely having accurate epicentral locations and depths for events provides strong criteria for the classification of an event as an earthquake or an explosion, since nearly all earthquakes initiate at depths greater than 5 km., or so, and explosions are usually constrained by drilling technology to be detonated at depths less than about 5 km. Thus, many events can be identified as earthquakes if their depth estimates are greater than, say, 10

km. and eliminated from further identification considerations. Identification of the remaining shallower events that might be detected near or at a test site can then be addressed using a combination of spectral discrimination methods involving both the first arrival compressional (P) wave, the relative excitation of observed compressional (P) to shear (S) waves, the relative excitation of Love and Rayleigh type surface waves and the magnitude of the P wave relative to the Rayleigh wave. In addition, for events that are sufficiently large and appear explosion-like, or cannot be positively identified, it would be possible, under a moratorium agreement, to call for an on-site inspection of the epicentral area. It therefore would seem very unlikely that any nuclear test within or near such a network could escape detection and identification. Furthermore, with seismic stations anywhere in the near vicinity of the nuclear test sites, it is probable that detection/identification can be achieved to very low event magnitude levels; in the case of explosions, down to yield levels of a small fraction of a kiloton, even if the explosion is detonated in a cavity in order to reduce the seismic signal produced (i.e. "decoupled"). Therefore, since only very small events might go undetected, and/or unidentified, it is in a practical sense quite possible to verify whether or not any militarily significant tests are being conducted at any site being monitored.

The details of seismic networks, much like those proposed here, and the technical aspects of monitoring a moratorium in order to verify compliance under the assumption that decoupled

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tests might be conducted, are discussed in the literature. In sum we find that to verify that a moratorium on nuclear testing is being observed by a particular country, it is adequate to install three or four high-frequency seismic stations encircling active or potentially active test sites within that country, and in this case not even perfectly decoupled low yield nuclear explosions at such sites could escape detection and identification. The NRDC-U.S.S.R. Academy of Sciences agreement therefore provides the type of monitoring required at test sites in order to verify a moratorium under all conceivable test conditions. To provide complete verification of a time limited moratorium, such monitoring networks would have to be installed at all other sites in the U.S. and U.S.S.R. that could, on short notice, be used for militarily significant testing employing decoupled methods. Therefore similar networks would have to be deployed at two or three other sites in each country to monitor a moratorium. However, the proposed deployment of three high-frequency seismic stations around the Semipalatinsk and NTS test sites can provide monitoring that is effective for verifying whether any tests down to much less than 1 kt. are being conducted at the only recently active test sites in each country. Furthermore, monitoring procedures can be tested and perfected during the project.

At the moment the Soviets are observing a unilateral moratorium and if routine analysis procedures are carried out using the U.S.S.R. data, it will be possible to verify strict compliance at this test site. While additional stations at other

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potential test areas in the U.S.S.R. would be necessary in order to achieve equally strict verification for the entire country, at the least the proposed network provides coverage of the most important and likely site for testing. Further, any tests above 1 kt. conducted elsewhere under normal coupling conditions (i.e. "tamped" explosions in close proximity to the surrounding medium), can be detected and identified by seismic stations outside the U.S.S.R.. Thus, use of the proposed local test site network and existing external stations provides monitoring capability that is, in a practical sense, quite adequate for verification of a very short term moratorium.

This project therefore serves as a model for the comprehensive monitoring required under a bilateral (or multi-lateral) moratorium. Further, the valuable knowledge and experience to be gained from the operation of the U.S. and U.S.S.R. networks should greatly increase confidence in the effectiveness of such monitoring and make any future wider deployment, under a bilateral agreement, much easier to accomplish. In this regard, a time-limited moratorium could be linked with the process of achieving a permanent Test Ban Treaty. The idea in this approach would be to initiate a seismically monitored bi-lateral moratorium for one year, with provisions for a short renewal if appropriate, during which time the technical details of a test ban treaty could be worked out with the aid of seismic verification data acquired during the moratorium. Thus a time-limited moratorium can become an important part of the process of obtaining a verifiable test ban

treaty, so that a moratorium, and its proper monitoring, has greater significance than one might assume at first sight.

Improvements in Yield Estimates

The principal difficulties and uncertainties associated with seismically estimating nuclear test yields arise from: (1) the variability in the coupling of the explosion to the solid medium due to nearly pointwise variability in the important mechanical properties of the ground-zero medium; (2) the lateral variability in transmission characteristics of the crust and upper mantle under a test site area and the often rather large differences in crust-mantle transmission properties between test sites; (3) the occurrence of a significant secondary source of seismic radiation which appears to be due to the release of initially stored "tectonic" stress within the medium by the explosively created fracture zone in the area around the detonation point. This highly variable "tectonic release" source is largely quadrupole in form and can, at least occasionally, strongly contaminate both the low frequency surface waves produced by the explosion and the high-frequency body waves as well.

All of these variable factors must be taken into account when estimating explosion yields, and uncertainties and errors in assessing their effects on the seismic wave fields produced by explosions leads to uncertainties and errors in determining yields. Of all these effects probably the most important is the difference in transfer functions of the crust-upper mantle beneath different test sites, since these differences introduce a

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large bias in yield estimates when empirical body-wave magnitude versus yield relations, from NTS tests, are used directly to infer Soviet nuclear test yields.

If it is not possible to calibrate a test site by direct means, that is by detonating large explosions of known yield or by recording teleseismic or regional events at or very near the test site, then all of the variable factors previously listed must be inferred by indirect methods. Up to the present time it has been necessary to use such indirect methods for Soviet test site calibration and, while these methods have certainly produced acceptable results, they have nevertheless been the subject of long debate and governmental uncertainty. Previously, the debate and uncertainty has been focused on the transfer function bias between the Soviet and the NTS test sites, and it is precisely this issue that can be most readily examined using data from the proposed project.

Obviously with stations in the vicinity of the Soviet test site it will be possible to obtain seismic data that can be used to more directly assess the effects of all these factors on yield estimation. Further, if Soviet test site explosions are recorded, then near-regional distance range estimates of yield, using different methods than are employed for teleseismic determinations, could be obtained and compared to the yield estimates obtained by the current "standard" methods. However, as implied above, even if no nuclear tests are conducted at a test site, it is still quite possible to obtain seismic data that is highly relevant to yield estimation for past or any future

tests.

Among the more important studies of this type are those involving the simultaneous recording of seismic events, particularly nuclear tests at NTS, by the seismic stations near the U.S.S.R. test site and those elsewhere in the world, including the three NRDC-Soviet stations established adjacent to the Nevada Test Site. In this case we can observe relative transfer characteristics of the crust-upper mantle beneath various recording sites (and, in particular, for the stations near the Soviet and U.S. test sites) when any type of seismic event is commonly recorded by both sets of stations. In addition, when U.S. nuclear tests are recorded at the Soviet stations, we will be able to obtain precise measurements of the seismic radiation over a wide frequency band for these explosions and can compare such observations with recordings of the same events at well calibrated stations in the U.S. and in other areas of the world. These data will allow quite precise determinations of broad band-very high frequency seismic wave propagation characteristics (i.e. attenuation) in the earth beneath the area around the Soviet test site. Thus, as with the other comparisons involving simultaneous recording of earthquakes and explosions, the Soviet recorded nuclear test data can be used to obtain new estimates of crust-mantle transfer function bias between NTS and the Soviet test sites.

Such a new bias estimate can be applied directly to adjust the average world-wide body wave magnitudes observed from past Soviet tests, so that with additional corrections for tectonic

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release differences, then NTS based magnitude-yield relations can be used to obtain new yield estimates of past Soviet tests. Through these methods we can therefore expect to provide calibration data for the Soviet test site and independent estimates of test yields that can be compared to other methods and their yield determination results.

Naturally, the same procedures can be applied at the U.S. stations to provide crust-upper mantle transfer function calibration for the NTS area, with this calibration being applicable over a broad frequency range. Such broad-band calibration, particularly in the high-frequency range, can be used to infer details of the frequency dependent behavior of attenuation in the upper-mantle and crust of the earth, at the different test localities, leading to a more quantitative description and understanding of the attenuation process appropriate in the lithosphere-athenosphere zones beneath these different geophysical provinces. Clearly, such new information could be used to establish more accurate propagation corrections for various types of body waves and surface waves, so that regional and teleseismic methods of yield estimation using a variety of wave types and paths could be used to determine yields over the whole range from very small explosions, near 1 kt., to those near 150 kt. and above.

Therefore, in addition to the simultaneous recording of teleseismic explosions and earthquakes at both test sites, it is important to record regional seismic events, particularly "small" industrial explosions and any nuclear tests, in order to

calibrate the test sites in terms of regional transmission characteristics. Specifically, inversion procedures, using multi-phase regional and teleseismic data, can be applied to deduce the anelastic and elastic structure in the areas that include the test sites. This structure information will then allow accurate propagation corrections to be made for such phases as Pn, Pg, Lg and Rayleigh type surface waves, to obtain yield estimates over the entire yield range of interest, using several different methods of yield estimation. (In addition, such structural information can be used for improved event epicenter locations and depth determinations, and so will indirectly provide enhanced event identification capability.) Additionally, if explosions at or just outside the test sites themselves are recorded, then directly applicable empirical relations, relating explosive yield to the amplitudes of the various types of seismic signals recorded, can be obtained and used for future estimates of nuclear test yields. For this approach we would, however, need announced, or otherwise known, explosion yields.

Since there are significant numbers of large mining explosions in the areas surrounding both the U.S. and U.S.S.R. test sites and since it should be possible to obtain information regarding their size and locations prior to detonation, it should be quite possible to use these events for such calibration purposes. Further, it may be reasonable to conduct supplemental experiments involving explosion detonations (in lakes for example), as a part of this project and to obtain additional important data related to high-frequency transmission

characteristics for the test site areas. Finally, there are also frequent, moderate-sized, earthquakes within the regional distance range from the test sites, and signals from these events can be used to infer detailed elastic-anelastic properties of the earth between the stations surrounding the test sites.

Therefore, we should certainly be able to determine the transmission characteristics of the crust and upper mantle at and in the immediate vicinity of the test sites.

Consequently, it is evident that we can conduct a number of investigations of the crust-upper mantle structure and signal transmission characteristics near/at test sites that will enable us to more precisely and confidently infer test yields from high-frequency teleseismic (or regional) compressional wave data. Further, these investigations should also allow us to determine, and verify, signal magnitude versus yield relations for a variety of signal types in the regional distance range. Once we have firmly established the transmission function characteristics of the test sites, then the other factors affecting yield estimation (that is, medium coupling in the detonation zone and tectonic release effects) can be accounted for with less ambiguity. Indeed, if the uncertainties of transmission are removed, then determinations of coupling, by use of multi-phase methods can be accomplished with considerable confidence. Likewise, the corrections of observed amplitude spectra of P waves and Rayleigh waves for tectonic release effects, as evidenced by the SH and Love waves observed from an explosion, can also be accomplished with more confidence and accuracy in both the regional and

teleseismic distance ranges.

To summarize the results that we can obtain, which are related to yield estimation and can be obtained from analysis of the broad band/very high-frequency data, we observe that it will be possible to obtain:

- (1) Estimates of "traditional" m_b bias due to differential attenuation of P waves from the Soviet test site relative to NTS.
- (2) Relative (and possibly absolute) spectral transmission functions for P waves, at the test site stations, from teleseismic events.
- (3) Spectral transmission functions for different wave types derived from elastic-anelastic structure between stations; with the structure obtained from interval (two or three station) inversion methods when applied to signals from regional earthquakes or large industrial explosions.
- (4) Empirical relations, for various signal types, giving signal amplitude versus yield in the regional distance range (e.g. for Pn, Pg, Lg and Rayleigh waves, in particular frequency bands); by signal amplitude measurements from industrial or experimentally controlled explosions in the areas of the test sites.

Based on such results, it will then be possible to:

- (1) Recompute past Soviet/U.S. test yields, from corrected m_b data, using the new test site transmission functions.
- (2) Obtain more accurate and confident determinations of coupling efficiency and the amplitude perturbation effects of tectonic release on various signal types.

(3) Establish theoretical/empirical signal magnitude versus yield curves for test sites, for various regionally recorded signal types, which can be used for multi-phase yield estimation for any future nuclear tests.

(4) Obtain more accurate epicenter and depth determinations of regional events around/at the test sites, for identification purposes.

It seems evident from these considerations that, with the addition of a few experimental initiatives, it would be possible to enhance the results to be expected from this project. Among the initiatives that would impact field estimation capabilities are the following:

- o Add one or more stations to the site monitoring networks to provide additional interval path data for structure inversions, as well as for additional event location capability.
- o Place temporary (portable) recording systems on the test sites to obtain recordings of large teleseismic explosions and regional events.
- o Detonate large chemical explosions at various distances from the test sites for site calibration and signal magnitude versus yield studies.

However, even without these initiatives, the three high performance seismic stations will undoubtedly provide observational results of great utility, particularly for yield estimation and the associated questions related to coupling and

tectonic release.

**Studies Relating to Verification of a Low Threshold
or a Comprehensive Nuclear Test Ban**

Quite detailed discussions of the technical methods that would have to be employed in order to provide seismic verification of a low threshold (1 kt.) permanent test ban are found in the literature. The technical problem can be viewed as consisting of two aspects, the detection and location of events above a low magnitude level and, second, the identification of these events.

Obviously if the number of stations and the number of on-site inspections were no problem, then we could install seismic sensors every few kilometers within each country in which verification was an issue and detect and locate every seismic event above some prescribed magnitude level. Then for any event that was found to be shallow enough to be an explosion (and failed other criteria for identification as an earthquake) we could perform an on-site inspection at the location of the event to look for evidence of the test itself and the activity associated with testing. It is unlikely that any country would attempt to secretly test under such circumstances. However, it is even more unlikely that such a verification procedure could or would be implemented on the simple ground of practicality. Nevertheless, this extreme example does serve to illustrate the fact that verification of a nuclear test ban by seismic methods is always possible, the question is: can it be done with a reasonable number and distribution of seismic stations. As

discussed in the literature, the answer is in the affirmative, provided the countries involved would agree to a 1 kt. low threshold test ban and the installation of around twenty-five high performance seismic stations within their borders. In this case, it appears that, with an additional fifteen or so stations outside each country, it would be possible to detect and almost always identify any explosion with a yield at or above 1 kt., detonated anywhere within the U.S. or U.S.S.R., even if the explosion were detonated in a large cavity which would reduce its seismic signal to the maximum possible extent (i.e. "fully decoupled" explosion). Further, if it weren't for the possibility of decoupling in cavities, then verification of such a 1 kt. threshold treaty could probably be accomplished to the necessary degree of certainty by external stations near the borders of each country.

There are, however, uncertainties in the estimates of numbers of stations required for detection and location of the in-country seismic events and also uncertainties in estimates of the number of events that could not be identified or were misidentified by the various purely seismic methods used for event discrimination. While it is argued that these uncertainties are not so large as to present a barrier to acceptance of a test ban treaty, it is nevertheless clearly appropriate to reduce these uncertainties and to also minimize both the numbers of stations required as well as the number of unidentified or misidentified events.

There are several observational tasks that would have to be

accomplished before very confident determinations of in-country station distributions and "verification efficiencies" can be obtained. All of these tasks require in-country seismic surveys, so that the project proposed here should provide at least some of the data required. Specifically, to achieve more confident estimates it is necessary to obtain more detailed data from (all) representative geologic regions within each country, with this data providing the following:

- (1) Signal propagation characteristics (attenuation with distance) for various seismic phases, particularly for very high-frequency P_n , S_n , Lg and Pg phases at regional distance ranges.
- (2) High-frequency noise levels (to 50 HZ) at quiet sites.
- (3) Tests of small event identification in the regional distance range by P wave spectral methods, as well as by multi-phase methods, such as those based on the relative excitation of P and S waves, P_n and surface waves and Pg relative to Lg , etc.

It is fairly evident that data required for investigations in these three areas will be available from the monitoring at the U.S. and Soviet test sites. Indeed, the methods described in the preceding section on yield estimation apply directly to the determination of signal propagation efficiencies. Further, the noise measurements required can obviously be made, so that at least the noise at three U.S. and three Soviet stations can be quantitatively described. Finally, in view of the numbers of regional earthquakes and mining explosions near both test sites,

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it will be possible to perform the required identification tests involving small earthquake-explosion discrimination. In addition, if nuclear events are recorded, then these can of course be included and studies of the differences between nuclear and chemical explosions could also be carried out as well.

The limitation of the NRDC-Soviet project is, of course, that such studies will be restricted to the regional distance range around the test sites -- that is out to around 1500 km. or so. To provide data for the range of environments required for confident assessment of network requirements, under a permanent test ban, such groups of stations would have to be placed, at least temporarily, at several locations in both the U.S. and U.S.S.R. and these same investigations repeated at each. Nevertheless, the data from the more limited NRDC-Soviet project can provide very valuable preliminary results.

Personnel

The Principal Investigator (P.I.) in the U.S. for technical aspects of the NRDC-Soviet project is Professor Charles B. Archambeau. Dr. Archambeau is currently an Adjoint Professor of Geophysics at the University of Colorado and a Research Associate of the Cooperative Institute for Research in the Environmental Sciences (CIRES). Professor Archambeau will have prime technical responsibility for the coordination and execution of the NRDC-Soviet project. He will be assisted by a research associate, who will participate in phases of management and coordination of the field projects in the U.S.S.R. and the U.S.A.

In addition to the personnel from the University of Colorado/CIRES, Dr. Jonathan Berger and Professor James Brune of the University of California will be Principal Investigators for a major subcontract between the University of California and the University of Colorado. These two Principal Investigators have the responsibility for the field implementation and operation of the monitoring project, for both the U.S.S.R. and U.S.A. In addition to these Principal Investigators, a number of scientists from the University of California at San Diego, and the University of Nevada at Reno, will participate in the field operations. The principal responsibilities of these latter scientists will be to operate and maintain the seismic equipment in the field and to perform basic analysis of the data obtained. They will perform these functions in cooperation with Soviet scientists who, we anticipate, will have similar responsibilities and objectives.

As previously noted, in addition to the U.S. personnel involved in this project there will be a number of Soviet scientists participating. Academician M. A. Sadovskiy will head the overall Soviet scientific effort, and Dr. I. L. Nersesov will be responsible for the Soviet field operations in the U.S.S.R. Two to three Soviet scientists are expected to be resident in the U.S. and will help operate the U.S. stations and will also perform routine analysis of the data. These scientists have not been identified as yet, but in any case there will probably be a rotation of personnel every few months so that numerous personnel will be involved. Expenses for these scientists, while in the

U.S., will be provided by NRDC.

In order to promote wide participation by qualified U.S. and Soviet scientists, and a means for cooperation between them a NRDC scientific advisory panel has been established. It is made up of U.S. scientists who have interest and experience in the seismic investigations that can be carried out under this program. The next section of this report discusses the functions of this committee and lists the membership. With distribution of the data to these and other U.S. scientists, as well as to Soviet scientists, it is our expectation that not only will the data receive careful and thorough analysis, but that cooperative studies between U.S. and U.S.S.R. investigators will naturally occur. We also assume that the Soviets will form a similar committee and in this case more formal interactions would occur between the scientific groups.

Scientific Advisory Committee: Membership and Function

A scientific advisory committee is an integral and important part of this project. The purpose of such a Committee is to provide a broad based overview of the scientific program. In particular, to provide recommendations concerning experiments that might be conducted and new methods and procedures for data recording, distribution and analysis. In addition, the committee will function as a point of interaction and cooperation between the U.S. and U.S.S.R. scientific communities, who have broad ranging interests in the seismic data in terms of its usefulness and importance for nuclear test verification, as well as in terms

of its applicability to basic seismological research.

The membership of the proposed committee (identified in Table 1) represents a broad range of seismological/geophysical expertise, with many of the individuals having been involved in government-sponsored research on verification issues since the inception of sponsored research in this area. Further, a number of them have been chairmen and/or members of government committees with responsibilities for the assessment of seismic verification issues and so can bring unique experience and knowledge to this NRDC advisory panel. The members will function as private citizens and, in this capacity, do not represent the institutions, companies or government agencies with whom they are presently, or have been, affiliated. They will not be requested to pass judgement or make recommendations on any political aspect of the proposed project. The intent in the formation of the committee has been to include representatives from institutions, government agencies and companies that are very active in aspects of seismological research that are related to the objectives of this experimental program. Therefore alternatives have been added in order to be sure that the key organizations will be represented, even if the regular committee member is unable to attend a particular meeting.

TABLE 1

NRDC SEISMIC MONITORING ADVISORY COMMITTEE (SMAC)

Charles Archambeau (Chairman)
Professor of Geophysics, University of Colorado, Boulder

Shelton Alexander
Professor of Geosciences, Pennsylvania State University

Jonathan Berger
Professor of Geophysics, University of California, San Diego

James Brune
Professor of Geophysics, University of California, San Diego

David Harkrider
Professor of Geophysics, California Institute of Technology
(Prof. Donald Helmberger, alternate)

Eugene Herrin
Professor of Geophysics, Southern Methodist University

Tom Jordan
Professor of Geophysics, Massachusetts Institute of Technology

Bernard Minster
Vice President, Science Horizons

John Murphy
Maxwell Laboratories

Robert Phinney
Professor of Geophysics, Princeton University

Stewart Smith
President, Incorporated Research Institute of Seismology

Michael Sorrells
Technical Director, Geophysical Systems, Teledyne Geotech

Lynn Sykes
Professor of Geological Science, Columbia University
(Prof. Paul Richards, alternate)

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